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OF
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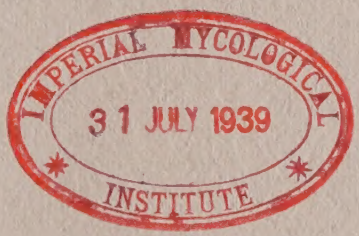

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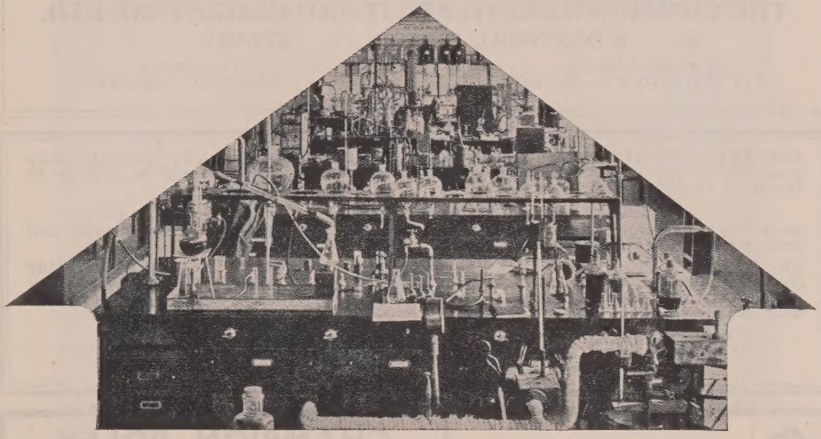

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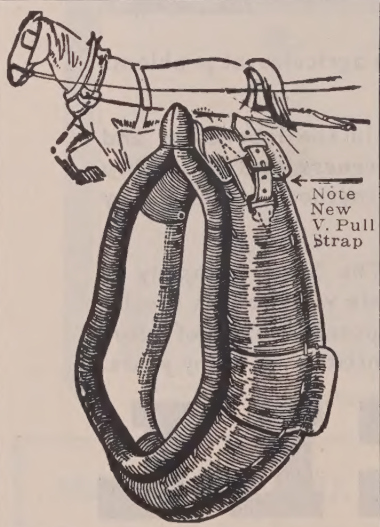

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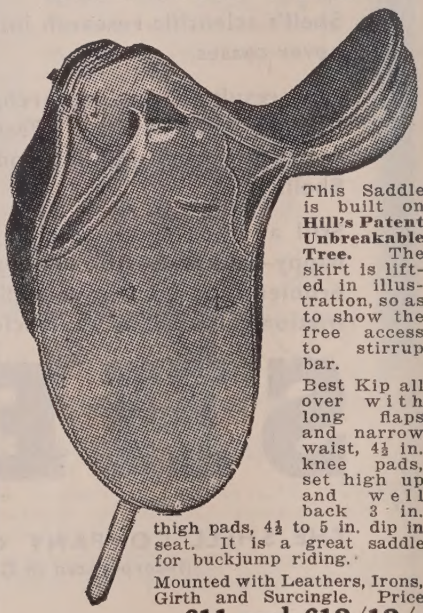

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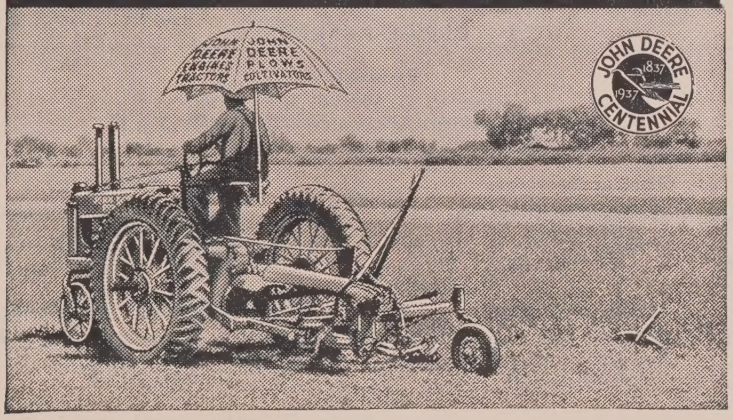

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Departments of Agriculture

Proud as we are of the freedom which we enjoy in a democratic community, the cynics among us state that such freedom is merely an illusion, and reference may be made to the ever-increasing volume of restrictions imposed upon us by governmental agencies under their powers of regulatory action. It is true that in agriculture and commerce and in the affairs of our everyday existence, one section after another may succeed in securing direct or indirect assistance from the community purse without realising that in the process, safeguards of some kind are necessary. These safeguards are devised by regulation, administered by an ever-expanding civil service, and although such a service exists entirely for the welfare of the community as a whole, the individual at times may be justified in his references to the " new despotism ".

Problems relating to the production and disposal of primary products in Australia are those which, in the first instance, receive attention by the Departments of Agriculture in each of the States. It is true that each Department is charged with the administration of a number of Acts and is criticised from time to time for the severity or lack of severity of the regulations under these Acts, according to the point of view of the observer. All the Departments, however, should be well aware of the fact that they are service organisations with very definite responsibilities to the community as a whole, while their more specific responsibilities relate to the welfare of the primary producer.

In the latter instance their functions are broadly those of research, extension and control, and although each departmental organisation may point with pride to its achievements in each of these directions, a more impartial survey would also reveal that there are instances in which errors of judgment, misdirected or even undirected effort have had serious repercussions on the welfare of the community.

Opinion may be expressed that certain sections of an individual department are more effectively organised and administered than others. May it not be assumed that differences of the same order exist between Departments throughout Australia? What is, indeed, the best possible organisation of these services for each of the States and what is the degree of effective coordination between them in the interests of the nation? We know that certain machinery exists even for the latter purpose, but is it really serving the purpose for which it was designed?

It might be assumed, at the outset, that a Department of Agriculture is in the best position to assess the relative importance of agricultural problems within the State and, having done so, its energies and resources are directed proportionately to their solution. If this were actually the case, then surely there would not be any need for the veritable flood of resolutions from producers' organisations, professional organisations and scientific societies, for the proposals and suggestions contained from time to time in presidential addresses and *ex cathedra* statements, editorial and otherwise, and indeed for the occasional Royal commissions on one phase or another of agricultural activity in this country.

What importance is attached by departments to the fundamental problem of maintenance of soil fertility? What steps are being taken, especially in this unstable world, to forecast the future position for producers of one crop or another? Are our resources in extension effectively marshalled, or is "the ceaseless torrent of printed matter which swirls past the farmers' eyes" an example of unbalanced activity, and therefore partially wasted energy? What are likely to be the economic effects of the production of disease-resistant varieties and of further developments in methods for control of pest and disease, and what, indeed, is the relative importance of the individual projects already undertaken by the various sections of a department?

Answers to such problems are not to be readily obtained, but one wonders whether the latter are actually receiving the intense consideration which they deserve. There is a feeling that much of the work of the departments is done as a matter of expediency ; admittedly there is a tremendous volume of so-called routine which must receive attention day by day, and those few who are charged with the administration of departments as a whole have but little time for thought concerning the problem of relative values. There would appear to be a need for provision of facilities which would make it possible for departmental activities to be more clearly defined at the outset, on a project basis, that these projects be evaluated, broadly at least, in relation to one another, that major problems should receive the attention they deserve even to the exclusion of minor issues, and finally it should be possible to take some stock of the position in recording progress year by year.

The principles involved are elementary, but fundamental, and the effectiveness of a department's service to the community may be considered to be directly proportional to the extent that such principles are put into practice.

Men Wanted*

By

J. Brake, B.Agr.Sc.,

Superintendent of Agriculture, Victoria.

The reason for selecting *Men Wanted* as the subject of my address was to stress the importance and essentiality of training plus experience in successfully holding down any worthwhile job, with particular reference to agriculture, and to point out the obvious need for experienced men of ability and vision to participate in the all-round development of this sparsely populated, vast country of ours.

It was most heartening to read the speech of the Prime Minister, Mr. Lyons, a few days ago, in which he was reported to say, " The national defence effort in its broader sense comprehends more than men and munitions, guns and war vessels, bombers and pursuit planes ; it embraces the accelerated development of industry ; thereby Australia will more rapidly become stronger, not only in man power, but in railways and roads and factories and farms, ships and docks—in all those things which make up that national economic strength which is so often the deciding factor in a war of attrition. In the supreme task of making Australia strong and prepared there is no room for idle hands ; and it is unthinkable that there should be any unemployed men in this country with so much work of innumerable kinds waiting to be done."

* Presidential Address to the Victorian Branch of the Institute, 31st March, 1939.

Surely this includes not only the development of industry in town and country, but also the systematic direction of agriculture and land-use generally in order to preserve and increase Australia's real capital, on which the very existence of the whole nation depends, namely, the fertility of her soils.

An endeavour has therefore been made in this paper, firstly to analyse the position without bias, admitting the impossibility of avoiding change, but suggesting there has been some all-round easing up on the part of Australians as citizens. Secondly, to stress that complacency must not be allowed to intrude, particularly in regard to the occurrence of any deterioration in our soils. Thirdly, to remind you that a very great responsibility rests on those who have elected to take up agricultural science as their life's work to ensure that the greatest possible foresight is used in the utilisation of land throughout the continent, and, finally, to express how necessary it is that the closest attention should be given to the training of agricultural workers to ensure their fitness for the important positions they will be called upon to occupy.

If human nature the world over were not as it is, possibly here in Australia, so far distant from Europe, we would be permitted to carry on without thought of the morrow, all the time not exactly wasting our substance in riotous living but certainly drifting (as we are) towards less work and more leisure, losing efficiency and becoming more and more slothful until the inevitable result would occur, as it has already occurred several times in history, of national decadence and absolute impotence.

It seems trite to bring up the old adage *There is no royal road to knowledge*, but however much we think this to be true, we hate to think it applies to us personally and are always looking for short cuts to more ease, whereby money or promotion may be obtained without going through the preparatory period that is so necessary to the development of experience and managerial ability. Recent events in Europe proclaim much more effectively than I could say, how necessary are men with such ability to Australia today ; men to lead as well as men to serve. For success, both leaders and led must be trained, with knowledge and discipline born of experience.

Nothing is static in life. Change is constant and universal and we have to work with it or go to the wall. This is not easy, for youth looks forward with confidence to the solution of all problems, while to the " not so young " the world appears as the plaything of ambition and fate ; it is only in old age that full disillusionment comes and one realises that the world's troubles are endless.

During the last one hundred years, the world war and advances in science, power, electricity, railways, internal combustion engines, aviation, communication, etc., have been responsible for change to a bewildering degree—generally called progress ! Probably never before has there been so much attention paid to " getting on ". From the " Self Help " of Samuel Smiles in the Victorian era there emerged the mighty drive towards money-making, especially

in America. Big business demanded efficiency and more efficiency. Then came business colleges, system schools, university commerce degrees, commercial art, classes of all kinds to meet the demand for more knowledge and training. Nation after nation, which hitherto had been content to live within its own boundaries, started to wake up and compete for world trade; and trade means power. Then the war stopped the racket, only to start it up again at a greater pace than before. After the war and its peace (?) treaties, economic nationalism reared its impossible head and competition as between country and country was keener and more bitter than it ever was before. Today world conditions are chaotic and he is a brave, if not foolish, man who dares to foretell what tomorrow will bring forth. Nations with huge populations, albeit all their citizens do not support the governing party, are challenging the world.

Australia—in the past remote and beyond the seas in so far as other countries were concerned—is no longer remote. Fast boats ply regularly, air-liners travel over every part of the continent and to and from other countries. Australia today is nearer and more accessible to many of these other countries which are looking for more land for surplus population.

Australia must wake up, for whether she wants it or not, obligations are being forced on her by the activities of other countries—activities not directed, at least in the first place, against Australia, but which arise from the not unnatural desire for self-expression and expansion of peoples recently awakened.

Notwithstanding, then, all the advantages in training, all the aids to efficiency which the last generation or two in this country have had, I believe that the title of this lecture, *Men Wanted*, truly expresses Australia's big problem of today. Australians are notoriously easy-going and have been reputed to be lacking in discipline, but notwithstanding this her troops, for example, during the war gained the reputation of being the finest shock troops in the world. Nevertheless characteristics of this kind may be extremely dangerous and there always exists the possibility of Australia providing an excellent illustration of the hare in its race with the tortoise.

Are we then resting on our oars? Living on the results of the initiative and achievements of our fathers and grandfathers, the Australian pioneers? There is always the temptation to relax, to assume that work has become a mechanical performance and that the real problem of mankind is how to spend the leisure hours for individual benefit and pleasure. Undoubtedly that is a serious problem, but it is not more important yet to know how to play than how to work.

World conditions at the moment tend to block from our ken considerations of all else save efficiency in war and defence. It is difficult to visualise anything more horrible and devastating than a war such as we appear to be approaching; yet I venture to say that the ultimate effect would not be as dreadful as that

which would be reached sooner or later by a nation whose people were neglecting their real duties to themselves and to their country.

Australia is young in settlement, but she is getting beyond the stage when any careless disregard of the future can be excused. On the contrary, foresight and careful planning are essential if we are to make use of the experiences of older countries and avoid some of the difficulties and troubles through which their peoples have lived.

We cannot risk neglect in this regard. People who are smugly self satisfied, like a nation in which superiority in power is allowed to breed arrogance, are due for a fall. As agriculturists, we are vitally interested in at least one of the directions in which complacency must not be shown by Australians, namely the continued productivity of our lands.

The publicity given to soil erosion and fertility losses in Australia in the last few years renders it unnecessary for me to enumerate here the sound reasons which exist for immediate and definite preventive action being taken. Suffice it to say that Australian agriculture appears to be at the crossroads ; either we allow the soil to go on being treated as an inexhaustible mine, deciding our methods and treatments on mere yields over periods all too short, or else we shape our own policy by recognising in our soils what has been recognised in soils of older agricultural countries from time immemorial, namely their inability to go on providing plant food for the production of farm products without their regular rehabilitation by rotation of crops and the application of fertilizers. Needless to say, the latter is the only rational course to pursue, and the hope, perhaps the only hope of a general movement by farmers in this direction, is dependent on the pursuance of a vigorous policy of education.

The task is not easy, the aim is somewhat Utopian in that it entails the sacrifice to some extent by the farmer of immediate gain, in order to ensure continued productivity, if not the bettering, of his soil in the future possibly the distant future. When it is remembered, however, that possibly the whole future of Australia is dependent on the maintenance of fertile soils, it would appear reasonable that the strongest support of that policy should be forthcoming from all good Australians.

The advances in chemistry and science generally in recent years have been enormous, but it is probable that we are still very far from a real comprehension of what goes on in the soil. In most cases, the fertility of the soil is measured, and its management governed, by the quantity of produce obtained without regard to quality or to the condition in which the soil is left. Obviously something more than this is desirable. If there could be developed some sort of simple yard-stick to indicate the true condition of the soil at any time, then much deterioration and loss of fertility of our soils could be avoided.

The practice at present seems to be to produce immediately as much as possible from the soil, with the least possible exertion and expense. Deterioration commences but it is insidious and not seen, or at least heeded,

until damage is done that takes years to remedy, if indeed, as in the case of severe gully erosion, any remedy is possible. A few instances of this type of damage in Victoria have been seen in recent years, for example, the failure of potatoes in one district to keep long enough for them to be marketed has been found to be due to watery wound rot—caused by a damping-off fungus. A survey of farms in the area indicated that the trouble was most severe on farms where rotation of crops was not practised.

The absence of increased yields from pasture topdressed with superphosphate, which formerly gave spectacular increases, has been remedied by the application of potash. Who knows what other damage has been done to the soil by thus apparently permitting the depletion of at least one plant food to occur to the point of exhaustion of the soil ?

The appearance of salt on irrigated fields is a world-wide problem and cannot be said to be solved, but it would seem that the trouble is due, at any rate partly, to incorrect land management or rather, in some cases, no management. In a recent interview with an old irrigation farmer, it was suggested that his land and crops would be better maintained, and his farming would be more successful, if he regraded his land and adopted the small bay system. He readily admitted this but explained that it would mean more work !

Practical Training Essential.

These are more or less spectacular cases but they refer to difficulties, no worse than thousands of others, with which farmers are confronted in all parts of the country, in regard to which is required the careful examination and advice of a trained man. This brings me back to the title *Men Wanted*, and when the word men is used it does not mean simply those who have qualified for certain academic degrees, into whom a lot of basic facts have been pushed with much pain and trouble ; but it means men who have, early in their training, realised the necessity for becoming equipped as early as possible with that knowledge supplementary to booklore which can only be obtained in active practical work (the medical graduate walks the hospitals for the same reason). It is seldom possible for one man to be competent to advise on all the activities of the farmer, but nevertheless an adviser, in addition to a specific knowledge in one or two directions, is expected to possess a good, all-round knowledge and sufficient initiative to see that any information he himself cannot supply is obtained from the appropriate source. Men competent to carry out work of that kind, particularly without constant immediate direction, are most valuable units and not easy to obtain ; they are of the type referred to when I say *Men Wanted*—men trained to think and to act, and competent to assume responsibility.

One of the greatest problems in designing any machine is to give the parts proportionately equal strength and life, and I feel very strongly, in this day of

specialisation, that in a course of training such as agricultural science there is a real danger of the knowledge and personal contact with farm operations being unduly subordinated to laboratory investigations and demonstrations and the enunciation of theories. There are at least two schools of thought as to how much actual contact with the practical work on the farm should be provided for in the course of training; some apparently think that the agricultural graduate should be a laboratory man, concerned with matters *of* the farm but not *on* the farm; others believe that the training for a degree in agriculture should include at least one full year plus vacation periods of practical work.

Experience has shown in ninety-nine cases out of a hundred that a training of university standing in agricultural science is essential, not only to research workers, but also to those performing advisory work amongst farmers. Great care, however, must be exercised to ensure that a fair measure of contact with practical farm operations has been gained prior to any graduate attempting advisory work, otherwise one *faux pas* after another may be made, the confidence of the farmer is destroyed, and a very serious setback to progress almost inevitably occurs. On the other hand, a man who is familiar with the farm as well as the laboratory soon comes to be regarded by the farmer as a very welcome friend and is usually soon in the position of being able to give, by reason of his scientific training and technical knowledge, a great deal of valuable practical advice. There is room in Australia for many more men with higher training in agricultural science, but there can be no argument, I think, that the greatest progress and greatest good nationally depends on at least 75 per cent. of them having their theoretical knowledge backed up by sound, practical training; which means considerably more than living for a few months on a farm as an interested spectator.

Anybody who has passed his examinations is generally employable, but graduates are expected to be something more than mere automatons. They are technical men who have deliberately selected agricultural science as their life's work, consequently enthusiasm and intense interest are expected of them. Promotion should not be automatic as it is unthinkable that a man, degree or no degree, should be placed in a responsible position unless he has had adequate experience. A former Director of Agriculture in Victoria once said to me, " Some of these men don't seem to realise that they have to *do* something before promotion comes their way ". Self-confidence is a very desirable trait, but self-confidence becomes conceit and downright foolishness when a person conducts himself as if saying, in the words of Sir William Orpen, " My face I don't mind it since I am behind it, it's the people in front get the jar ". Any graduates who are unfortunate enough to be afflicted in that way will soon find that they themselves get the jar, not the people in front.

Conclusion.

Enough has been said, I hope, to present a fair picture of matters which are undoubtedly of the greatest moment to Australia. In addressing people, such as my audience this evening, who have been closely associated with agriculture, there is no need to dwell any longer on the necessity for the recognition of the supreme importance of the maintenance of a high standard of fertility in our soils as an essential factor towards the continuance of Australia as a nation. It is suggested, however, that advantage should be taken of every opportunity that occurs to drive home a full realisation of this cardinal fact among the people as a whole.

The average man's time is generally fairly well occupied in connection with his own business and local activities; consequently we must not be disheartened if their interest is difficult to arouse but must persist until success is attained to such a degree that the governments recognise it as the will of the people that very definite action be taken. And in claiming that the greatest success in such a policy can be hoped for only by the utilisation of agricultural science to the full, we must not fail in providing the necessary men with sound scientific training and adequate practical experience.

Man-Power in the Service of Agricultural Science*

By

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It is essential in a discussion of this nature to define one's terms at the outset, and it is especially necessary to point out that the term "agricultural science" must not be considered in a circumscribed manner. Agricultural science must be taken to include not merely the academic subject and the scientific discovery of basic facts in relation to agriculture, but also the application of the principles both by the scientific worker and the man actually practising agriculture. The economic aspect also demands attention, and one of the functions of agricultural science in general is to see that all of the activities are coordinated efficiently. Man-power similarly involves considerations from more than one angle, for instance, availability, provision, organisation and utilisation of man-power.

* Summary of Presidential Address to the Queensland Branch of the Institute on 31st March, 1939.

In Queensland, the most notable advance during recent years in terms of the quantity and quality of research, technical and extension work has been provided by the State. At the same time it is still recognised that we have a long way to go. Further progress requires an analysis of the problems to be tackled and of the type of personnel necessary. For some agricultural problems a training in the Faculties of Science and Applied Science, coupled with an acquaintance with agriculture in its practical aspects, may be more useful than a strictly agricultural degree. A further consideration arises in the matter of financial provision for the staff. It is difficult to get first class men to meet the needs of agricultural science, and this difficulty is bound up with the relatively unattractive opportunities offered to those with an aptitude for applied biological work, compared with those, for instance, offered in medicine and dentistry.

Again, there is at present too much emphasis on research work only, whereas today what is required in addition is better provision of extension services. This lack is unfortunate because research or investigational work will get nowhere unless accompanied by equivalent extension work. The application of scientific farming necessitates a scientific producer, and we must build up a community capable of applying the findings of science—a function of adequate extension work.

In so far as research and technical activities are concerned, the two main organisations are the Department of Agriculture and Stock and the Council for Scientific and Industrial Research, inasmuch as they represent the State and Commonwealth authorities, respectively, in which are vested the major responsibilities. When a plan has been devised whereby their responsibilities and activities can be determined and implemented, it then becomes the responsibility of the Department of Agriculture and Stock to coordinate effectively all other departmental, semi-governmental and extra-governmental activities within the State with its own activities.

Constitutional, geographical, and many other practical considerations place, at this juncture in our history, very definite limitations on the idea of a Commonwealth or National Department of Agriculture in Australia. In South Africa, a Union Department of Agriculture has replaced the various Provincial (State) Departments ; but it is to be borne in mind that the total area of the Union (including Cape Colony, Orange Free State, Transvaal and Natal) is only two-thirds of the area of the State of Queensland. It is, further, specially noteworthy that the Constitution is one of union, and that our Federal Constitution invokes an entirely different arrangement in respect of National and State organisation. It would be rash and unjustifiable to regard the Federal and State organisation of activities within the United States of America as being ideal for, and capable of easy or early application to, Australian conditions. It would seem, then, to be the essence of wisdom to evolve some plan of Commonwealth and State activities organised on a basis of coordination

and cooperation, that will meet effectively the needs of problems confronting primary production, and to allow time and experience to discern and determine the plan of Commonwealth and State responsibilities and administration best suited to serve the national and developmental needs of Australia.

Queensland Department of Agriculture.

Accepting that position, it is then relevant to consider the functions and responsibilities of the State Department of Agriculture and Stock. They would appear to be constituted by the following :

(*a*) Utilisation of the primary producing potentialities of the State by protective and developmental means so as to secure and ensure the maximum of benefit possible in terms of :

- (i) Quantity, quality and variety of production.
- (ii) Regularity and continuity of production.
- (iii) Production on an economic basis so as to ensure, in conjunction with (i) and (ii) the maximum of demand on overseas and domestic markets.

(*b*) Conservation of the potentialities of the State in relation to primary production, in such a way as will ensure :

- (i) Maintenance of soils and soil-productivity, and transmission to posterity of soil potentialities by combating the influences of hostile Nature, human despoliation, wastage, and uneconomic utilisation of lands through thoughtless expediency and/or lack of advice.
- (ii) Control, conservation and utilisation of waters.

(*c*) Maintenance and extension of the primary producing population by :

- (i) Providing, or rendering available, competent and coordinated research and technical services in relation to problems of a protective, developmental or conservational order.
- (ii) Providing to those engaged in primary production, efficient extension and administrational services in relation to protective, developmental and conservational activities ; and offering advice that is sound from the scientific and technical, practical and economic aspects.
- (iii) Effecting :
  - (*a*) An agro-economic survey of the lands of the State.
  - (*b*) A farm-costing survey within individual primary industries and areas.
  - (*c*) A census of production and potentialities-of-utilisation of lands and products, with a view to offering guidance in the economics of production.

(*d*) The implementing of information gathered by such surveys in the interests of the primary-producing community, thereby ensuring increasingly greater economic security to settlers, and stimulating interest on the part of a greater section of primary production.

(iv) Organising or facilitating provision for handling, transport and organised distribution and marketing of products on a sound economic basis and in accordance with a planned developmental land-utilisation policy.

(v) Ensuring the fullest facilities in connection with all aspects and types of agricultural education and training.

The discharging of such functions and responsibilities involves a great variety of activities, of a scientific and technical, practical and economic order, in connection with the manifold aspects of which many bodies or organisations are involved. In addition to the Department of Agriculture and Stock and other government departments whose activities impinge on varied aspects of problems associated with primary production, there are institutions or organisations of a semi-governmental nature or functioning under the ægis of the Department of Agriculture and Stock, whose activities and interests must find a place in any plan of organisation designed to satisfy the demand for cooperation and coordination in the interests of State economy and efficiency as well as in the interests of primary producers. There remain for similar consideration the activities of various extra-governmental organisations or bodies, etc., and individuals.

The coordination and utilisation of all these intra-State services on a basis of mutual cooperation, and the relating of the same to effective attack on our problems should be accepted as a responsibility of the State, and that responsibility should be regarded as being legislatively deputed to the Department of Agriculture and Stock.

The question of allocation of spheres of activities to State and Commonwealth in so far as those relating to matters of a research and technical order are concerned, and that of coordination of State and Commonwealth activities, becomes easy of solution provided that the State equips itself with efficient staff and effectively coordinates all intra-State activities.

The Future of the Australian Population

Our Institute's present attempt to estimate the agricultural potentialities of Australia must have led many to think out the implications of such a survey. The problems that are raised in any discussion of future developments are very complex, and in order to bring certain aspects of the subject before our members, the following article has been prepared. It consists of an abridged form of a paper which Mr. A. Smithies presented to the British Commonwealth Relations Conference held at Lapstone, N.S.W., in September, 1938.

Present Trends and the Probable Future Population.

The natural increase of the population depends ultimately not on the birth rate and the death rate, but on the capacity of mothers to replace themselves. This is expressed numerically as the " net reproduction rate "; if this figure is less than one the population is bound to diminish in the long run, although the higher fertility of twenty and thirty years ago will be reflected in an increased population for some years to come. The net reproduction rate for Australia is very close to one* ; this means that the population may be expected to rise to 8,000,000 between 1970 and 1980, and then remain steady. A reversal of the present trend is only conceivable as a result of strenuous government action directed to making childbearing a profitable occupation. Since this is unlikely, a desire for a greater population than that indicated above implies a willingness to encourage immigration.

The problem of immigration is conditioned firstly by the policy of White Australia, and secondly by the workers' resistance to a lowering of their standards. The problem is removed from the realm of *laissez-faire*, and will not in any sense solve itself. If the country is to have immigrants on any appreciable scale it must adopt a definite policy to that end. If it does not adopt such a policy it is probably not very far from the truth to assume that net migration will not affect future population movements. In any case, if migration is to take place on a large scale, the immigrants will have to be drawn from non-British sources.

The upshot of the argument then is that the assumption that present tendencies will continue into the future is a reasonable basis for an estimate. Our next problem is to consider whether there would be any advantages in taking deliberate steps to reverse present trends.

The Advantages of a Larger Population.

The chief arguments for a larger population fall under the heads cultural, defence, and economic. Our chief interest is with the economic, but since economic considerations arise on the cost side in making any decision about

* The corresponding figure for most European countries, including England, France, and Germany, is below one.

population for cultural or defensive reasons, it is worth while to examine these arguments also.

(*a*) *Cultural.* It would be absurd to suggest that cultural development is necessarily dependent on the size of the population. One has merely to call to mind the Scandinavian countries and Ireland to refute this suggestion. But that does not mean that the growth of population may not be expected to promote cultural development. Cultural development depends on the absolute number of people engaged in its pursuit rather than on the relative number. The vital point is that there are, say, 10,000 people interested in the growth of a national literature. It is not highly relevant that there may be millions who are not. In fact the 10,000 may thrive more if part of a large population than a small one. Hence the argument is valid that an increase in population will stimulate cultural development unless it can be shown that the population growth would bring with it either no increase or a decrease in the numbers interested in intellectual pursuits.

(*b*) *Defence.* It is frequently urged that an increase in population is necessary for the defence of Australia. There seem to be two strands of thought on this subject. First, there are somewhat ambiguous rhetorical utterances, which seem to suggest that the mere fact of filling the empty spaces will reduce the possibility of invasion—Australia will be able to maintain a greater moral right to her territory if she populates it. It is hard to see that such arguments contain any substance. The density of China's population seems to be no protection. And would not a potential aggressor cast an even greedier eye on spaces that had been tilled and cultivated than on those that were merely empty ?

The more serious argument, but the one naturally more distasteful to politicians, is that larger armies can be raised from a larger population. But is capacity for defence a mere function of numerical strength ? It would seem that it is becoming less and less so. Mere numbers cannot resist mechanical strength, and mechanical strength depends on the wealth of a country rather than on its population. If defence were Australia's sole objective, and the alternatives were aeroplanes or immigrants, there seems little doubt as to which would be more effective. Of course if it were not a matter of alternatives and more immigrants increased the capacity of the country to buy aeroplanes, there would be no argument. But then the immigration would be worth while for general economic reasons not necessarily associated with defence.

(*c*) *Economic.* The arguments for or against a larger population must rest almost entirely on economic grounds. The pertinent question is what effect will population increase have on real income per head ?

The measurement of real income is a problem that continues to defy economists. The desideratum of course is a thermometer that will measure the total satisfaction a man derives from his environment. Such an instrument

is not available. Probably the best method is to follow the lead of the Commonwealth Arbitration Court (and other real-wage-fixing tribunals) and to measure real income by the purchasing power the community has over a standard list of commodities. The standard is fixed by finding the average consumption of the bulk of the community. This method raises a host of objections. What of the part of income that is not spent on the standard list but is saved and spent on roads, dams and bridges ? What of people who do not conform to the standard ? What if prices alter so that people change their relative consumption of various commodities and so make the standard obsolete ? The last objection can be partially met by revising the standard from time to time, but this precludes the possibility of comparisons between times before and after the revision. The other objections cannot be met, and our method remains a very clumsy and inefficient instrument.

We can say, however, that the economic aim of the community is consumption, that the bulk of the community do not save very much, so that an increase of consumption standards raises a *prima facie* case that conditions are improving, and *vice versa* for a decrease. But the matter must not be allowed to rest there. The community may be maintaining its consumption standards, but not keeping its capital intact, so that consumption standards will fall off in the future. Again, consumption standards may be rising, but if they were not rising so fast, capital might be accumulating more rapidly, making ultimately for higher consumption standards in the future. What is meant by maintaining capital intact is implicit in the foregoing sentences. It means maintaining the capital equipment of the community in such a condition that present consumption standards can be maintained. Consuming and accumulating capital have corresponding meanings with reference to lowering or raising consumption standards in the future.

We may seem to have strayed into academic by-paths, far removed from the subject of this paper. But it is essential in problems of this sort to bear in mind that there is no simple or definitive answer that can be given to the real income question. It is a glib term on everyone's lips, but when analysed from the point of view of long-run policy, it assumes a vagueness and complexity that must infect any argument of which it forms the basis. But consideration of real income cannot be burked.

The Question of the Optimum.

We can now attempt to formulate the relation of population to economic well-being. The argument falls into two parts. Firstly, to determine whether there is an optimum population from the point of view of economic well-being, and secondly, the conditions under which it can be attained.

(*a*) In order to realise the nature of the first problem, we may consider a simple case. Consider a primitive community living on an island with no foreign trade. The people wear boots and eat potatoes, and the production

of boots and potatoes is their sole economic activity. One section of the community produces the boots and another the potatoes ; and each exchanges part of its product with that of the other so as to achieve the highest consumption standard that is consistent with the amount of effort they are prepared to expend. The question is : is the consumption standard of this community in any way dependent on the population ? The answer depends on the laws of returns that prevail in the making of boots and the growing of potatoes. If both are subject to diminishing returns, an increasing population will have a lower standard of living and if the population increases indefinitely its standard will eventually reach a subsistence level. But suppose potatoes were subject to decreasing returns as before, while a large number of people producing boots for a wider market permitted increasing returns in boot production. Here there is a possibility of increasing consumption standards. Under the new conditions, a smaller proportion of the community could produce its boot requirements leaving a larger proportion to battle with decreasing returns in agriculture. Obviously in such a case there is a magnitude of population which realises the maximum standard of consumption.

It may be a permissible generalisation to say that an increase in population will make possible increasing returns in processes of manufacture, but it is probable that a point will be reached where decreasing returns set in in the production of relatively unmanufactured foodstuffs and raw materials.

Let us proceed to another point. Suppose our primitive community has to maintain a road across its island, and the size and quality of the road are independent of the size of the population. Clearly, the larger the population the smaller the proportion of the national income that must be expended on the maintenance of the road. Even if the wear and tear on the road were greater with a greater population, it is quite possible that the increase of cost may not be proportionate to the increase of population.

So far we have assumed a self-contained island. Suppose now that its inhabitants also wear hats, and that they must obtain the hats by exchanging boots for them with a neighbouring island whose population and consumption standards and productive methods are stationary. To support a larger population in the first island it is necessary to increase its boot output not only to provide its own population with boots, but also to buy more hats. By hypothesis, there is no increase in the demand for boots in the hat island. Hence the increased supply of hats can only be obtained by selling boots more cheaply, and this worsening of the terms of trade will tend to offset the benefits of increasing returns in the boot industry and so to diminish the size of the population which maximises consumption standards.

Of course, conditions in the outside world may not be stationary. They may be changing in such a way that demand for the products of the country we are considering is increasing, so that instead of a deterioration, there will

be an improvement in the terms of trade. This will tend to increase the size of the optimum population.

We can now summarise this stage of the argument. We have shown that there is a population which we call the optimum population, which can maximise the consumption standards of the community. The size of this population will depend on :

(1) The extent to which diminishing or increasing returns prevail in the various branches of domestic industry.

(2) The decrease in the cost of maintenance of capital assets of the community due to increase in population.

(3) The effect of population changes on the terms of trade with other countries.

(*b*) The fact that there is an optimum population greater than the present does not imply that if the present population continues to increase, its consumption standards will necessarily move towards the maximum—at any rate immediately.

Suppose in our primitive example a flow of immigrants arrived on the island—and the capital equipment and land remained unchanged. The immigrants would encounter diminishing returns at all points. They would have to produce potatoes on poorer land, and produce boots by working existing equipment more intensively—in which case, except in very unusual circumstances, it would yield diminishing returns. Hence the advent of the new population would be marked by a general fall in real wage rates and in consumption standards of the bulk of the population.

Now in Australia, we must reject an immigration policy that will reduce standards of living, even temporarily. Any extensive immigration must be reconcilable with the maintenance of present standards. Thus we must rely on some other factor than the effects of increased immigration to stimulate new investment in the industries of potentially increasing return. These secondary industries, if they are to be spurred into activity, must be confronted with an increased real demand for their products, in one of the following ways :

(1) Increased income from exports.

(2) Government investment. In so far as the government's activities merely divert resources from private investment, they do not affect home consumption. However, such activities will be mostly confined to times of depression and so tend to cure cyclical unemployment rather than promote large-scale immigration. Other possible spheres of governmental action are borrowing abroad or encouraging private investment from overseas.

(3) The government's other main weapon is to give tariff protection to industries where increasing returns may be possible. The " infant industries " argument is theoretically sound, but it is almost superfluous to point out that it has not emerged from the test of history with a stainless reputation.

Is the Present Population Below the Optimum?

Let us first consider the question of optimum population under the three headings of returns, capital assets, and international trade.

(i) *Increasing returns* may be expected from Australian manufactures, through the usual economies of mass production. It does not follow, however, that increasing returns will operate as strongly in Australia as elsewhere, or that real costs of production can be reduced to as low a level as prevails elsewhere. Suppose that transport plays a greater part in ustralian productive processes than, say, in England, and that increasing returns are not appreciable in transport. Then mass-production economies in other parts of the productive processes, even if equally available in both countries, will bring about a smaller proportionate decrease in unit costs in Australia than in England. Again, we are postulating no reduction, but an increase in living standards, and if these standards in Australia are continually higher than those prevailing elsewhere, the absolute level of real costs in Australia may remain permanently higher than elsewhere. These considerations will become relevant when we consider the international trade position.

The possibilities of *decreasing returns* lie in the raw materials and foodstuffs industries. Australia has abundant and accessible supplies of coal, iron (although doubts have been raised here) and other base metals. There are hopes of mechanical improvement in the cotton industry, and the present obstacles to the meat and dairy industries arise from deficiency of demand rather than from decreasing returns. The country's production of wool and wheat are, of course, far in excess of local consumption. If these industries were to expand appreciably, decreasing returns would probably operate. Whether or not the industries would expand with a larger population depends on the effect of population growth on the magnitude of the country's export trade, which depends on a larger population's demand for imports.

(ii) *Capital assets.* There is very little to be said in this regard. Australia has more miles of railway per head than almost any country in the world, and the cost of maintenance per head is correspondingly high. From this point of view the optimum population is indefinitely great.

(iii) *International Trade.* The crux of the matter seems to be in the aspect we have yet to discuss—the oversea trading position. The development of Australian manufacturing would probably reduce the amount of imports per head, but the expansion of population would almost certainly increase the total demand for imports. The United States, which is probably more self-sufficient than Australia can ever hope to be, has imports about six times as great as those of Australia. To meet this increased demand, the Australian export industries would have to expand.

What then are the possibilities of expansion of Australia's exports? The country must rely on exports of primary products. Wool, wheat, butter and

meat all have fairly inelastic demands, and an export of increased quantities would probably result in a considerably smaller proportionate increase in total values. That is, Australia's terms of trade with other countries would deteriorate. We have said above that expansion of wool and wheat production would probably be subject to decreasing returns. There are, however, possibilities of improving technique of production, but, especially in the case of wheat, these improvements are not likely to be confined to Australia, and if world production of wool and wheat increases owing to improving techniques, we are likely to lose on the swings what we gain on the roundabouts. It is as well to get this matter in the right perspective. A figure of 20 million for Australia's future population is often quoted as a not unconservative estimate. It does not seem an unreasonable guess that for a three-fold increase of population, Australia should have to double the value of her exports in order to pay for the imports she required. It is interesting to speculate on how much more wheat and wool would have to be produced, both to provide for increased home consumption and to make their contribution to doubling export income—and also what the cost of production would be.

We can now sum up. The factors favourable to an optimum population appreciably greater than the present are the possibilities of increasing returns in manufacture and the increased " productivity " of capital assets. The unfavourable factors are the possibility of decreasing returns in most primary industries and a deterioration of the terms of trade with other countries.

How a Larger Population can be Secured.

We have seen that for a rapid increase of population we must have one or more of the following conditions fulfilled : an increase of export income ; oversea investment, probably by governmental borrowing ; tariff protection. The possibilities of effective action in these fields are matters for detailed investigation ; all we shall do here is to take note of some of the more important points.

(*a*) Income from exports may be increased either from an increase of production or an improvement of export prices. This subject has been treated with admirable lucidity by Professor S. M. Wadham in a paper published in *The Future of Immigration into Australia.* His conclusion is that future development must take place in the relatively high rainfall areas, and chiefly on areas in which more intensive cultivation is practicable. This process will require considerable investment and careful scientific research into the problems of intensive farming. He concludes that " this process ought to be stimulated but not to such an extent as would be likely to lead to a rapid increase in the amount of produce available for sale in the world market ". In short, a mere increase in the quantity of exports without the opening up of new markets is not likely to be an effective method of increasing export income.

(*b*) Governmental borrowing overseas is not likely to become a major factor again. The chief prospect of investment from overseas is probably in the field of private investment; but without some active governmental stimulus it is not likely that the flow will be sufficient to form the basis of large-scale immigration.

(*c*) The tariff, if cautiously applied, can be useful and effective, but it can hardly be the basis of large-scale immigration.

The conclusions of this survey of the Australian problem may appear to be utterly pessimistic. They are pessimistic about large scale immigration—of the order, say, of 50,000 immigrants a year. But only as to that. Immigration on a smaller and rather select scale could play a distinctly useful part in Australian life. No one can deny that in the future development of the country, the benefit of talent and experience from countries that have already faced the problems that Australia is now facing would be invaluable—both in assisting the growth of secondary industries and in the expansion into "tertiary" production. Our analysis also has recognised the possibility of unspecialised immigration under the auspices of sound investment schemes that would stimulate aggregate demand on a fairly small scale. As far as one can see there has been an annual net import of capital amounting to several millions during the last few years, and the Australian governments realise the desirability of encouraging this flow. These imports will certainly pave the way for some immigration which our arguments have shown is economically desirable. What we do emphatically repudiate are those astronomical estimates of the early post-war year—reaching as high as sixty million—as being both desirable and attainable.

The Importance of "Minor" Elements in Western Australian Agriculture*

By

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Before chemistry gave to the world the conception of elements and their compounds, plants were considered to be fixed water or composed of air, fire, earth and such "principles". In 1804, de Saussure of Switzerland gave the first modern account of the growth and requirements of plants, and by 1840 Liebig gave a list of ten essential elements for plant growth. This list, except for the replacement of silicon by iron, stood for about eighty years. Three of the essential elements, nitrogen, phosphorus and potassium, are provided in so-called "complete" fertilisers, which have been such an important supplement during the last century to the inadequate supplies of farmyard manure for the production of the world's food supplies. Farmyard manures really approach completeness, as they return to the soil the bulk of the minerals removed in the crop, but the artificial fertilisers stimulate crop growth and hasten the depletion of elements not supplied. The modern use of synthetic and purified concentrated fertilisers increases the rate of depletion. It is now known that depletion is not confined to the "big seven"—calcium, magnesium, potassium, iron, sulphur, phosphorus and nitrogen—but to other elements as well.

Besides the well recognised essential elements, scientists devoted their researches to the effects on plant growth of a large number of other elements, and in the twenty years prior to 1910 the stimulating effect of many elements in small quantities was demonstrated. That some of these were actually essential was not realised, as soils or cultures entirely devoid of them had not been used, and they were simply regarded as catalytic fertilisers or stimulants. Later, refinements of experimental methods and carefully purified chemicals established the essential nature of a number of elements, at least for certain plants. They are required only in minute amounts and are now commonly known as "minor" elements, though the term "trace" elements is also used. The list includes boron, manganese, zinc, copper, and possibly molybdenum, aluminium and silicon.

On the animal side, a number of elements are known to be essential for normal growth. Especial interest attaches to cobalt, which was found by Marston in South Australia in 1933 to be essential for the health of sheep,

* Résumé of Presidential Address to the W.A. Branch of the Institute on 31st March, 1939.

and by Underwood and Filmer in Western Australia to be the principal curative element for Denmark wasting disease.

The use of copper, mercury and other compounds to control bacterial and fungal diseases of plants has been practised for many years, while nitrogen, phosphorus and potassium have remained the chief fertilisers for correcting soil deficiencies. With the recognition of the essential nature of some of the " minor " elements, many plant and animal disorders have been associated with the deficiency of one or more of these " minor " elements and corrected by their use.

Soil Conditions in Western Australia.

It is natural to expect soil deficiencies to be most prevalent on sandy soils, on soils which have been subjected to heavy rainfall over long geological periods, where the underlying rocks are deficient in important minerals, and where the composition of the soil renders the substances unavailable. Western Australia has a liberal proportion of sandy and gravelly soils, and one would expect this State to be a promising field for the application of the newer knowledge in plant and animal nutrition.

A brief review of the possible history of many W.A. soils will render this view more clear. Not only are many soils sandy and gravelly, but they have been very highly leached or washed by rain. Millions of years ago this portion of the continent was a low-lying, undulating plain subjected to a high rainfall. Much of the plant food was washed away, and soils with a sandy surface and ferruginous gravelly subsoil developed. This subsoil is now represented by the extensive occurrences of so-called laterite. It is not continuous, since following uplifting of the land, erosive activity was renewed. The underlying rocks were exposed in huge broad valleys, and soils have formed on granitic and basic rocks. With adequate rainfall, those formed on the basic rocks are generally most productive, while the granitic and more sandy and gravelly soils are less satisfactory both for crops and stock, in spite of liberal treatment with the usual commercial fertilisers such as superphosphate, sulphate of ammonia, etc. Practical experience with stock has taught farmers the advantages of running animals for a period, at least, on the heavier soils. Thus a general body of practical experience suggests that factors such as " minor " elements may prove of immense value on considerable areas in W.A. for both crop growth and animal nutrition.

Results with Minor Elements in Western Australia.

A number of interesting responses has already been obtained, and the future may show further instances of minor element deficiencies.

In the Albany district, copper has given remarkable increases in yields of potatoes and oats, and seems likely to overcome the deterioration of potato

crops when grown from local seed. On the wet, sandy, bottlebrush flats about Albany, which have proved very difficult to pasture, copper has induced an excellent growth of subterranean clover and has enabled maize to grow. Even on good, karri, hill land copper has produced well-filled pods on peas instead of " puff boxes ".

Marly swamp soils at Albany have given good responses with manganese and copper, and Herdsman Lake, near Perth, may show similar responses.

On poor, gravelly sand plain soil at Wagin copper raised the wheat yield from about two bushels per acre to over 25 bushels per acre. This lead may be an important one in the development of the sandy and gravelly wodgil soils so common in the wheat belt.

The grey speck disease of oats occurs in limited areas in the inner wheat belts and is controlled by manganese applications.

Copper has been successfully used since 1924 to control exanthema of fruit trees, and more recently for " wither-tip " or " summer dieback " of apples, and mottle-leaf of figs.

Mottle-leaf of citrus trees near Perth has responded to zinc sprays, while on poor sandy country further south unthrifty pines have been greatly improved by zinc sprays or other zinc treatments.

On the animal side, the curative effect of cobalt in the Denmark wasting disease of cattle and sheep is well known. More recently copper has been shown to be an important factor in the control of enzootic ataxia of sheep at Gingin.

It is not to be expected that all W.A. soils will show responses to minor elements. In fact, many important agricultural soils of the State show evidence of a high mineral status except for phosphate. Furthermore, the use of minor elements must be approached with caution. In one experiment with wheat on light land at Wongan Hills, zinc sulphate applied at the rate of 20 lb. per acre severely depressed the yield and produced a shrivelled grain of steely grey appearance. It is felt, however, that within a few years conditions will be defined under which minor element responses may be expected and the way pointed to more efficient farming, especially in those areas which are climatically the most safe.

The Artificial Stimulation of Soil Movement*

By

J. Macdonald Holmes,

Professor of Geography, University of Sydney.

The processes of erosion are complete in three stages—disintegration, transportation, and deposition. Soil is therefore a product of movement. It is a movement—mechanical, chemical, or both—which is always present and must continue until soil is no more ; still only in non-existence, at last a mere sand residuum.

Now soil movement has a natural momentum which is given to it at its birth as the resultant of the forces, ceaseless and impersonal, that sculpture the land surface. Of their own volition soils grow and also decay. These are the first principles in any consideration of so-called soil erosion. Secondary considerations show that certain agricultural, pastoral, forestry, and road making processes usually accelerate soil movement in directions adverse to soil maintenance, and likewise adverse to farm husbandry.

These artificial accelerations require to be known, otherwise farmers " are fighting rearguard actions " at their own and the nation's expense. Certain aspects of these matters indicate the points at issue, and they can be grouped briefly as follows† :

(1) The effects of developmental projects, e.g. road making.

(2) The effects of agricultural and farming practices, e.g. bad layout of paddocks with reference to the grain of the country.

(3) In arid areas, wrong technique in stocking policy.

With reference to (1), the net result of all developmental projects is a system of artificial drainage which, were it complete, would greatly add to the value of the region. But so incomplete is present road drainage design that excess rain water is turned almost indiscriminately into open paddocks and sets up torrential erosion in places not normal to the landscape.

With reference to (2), bad layout of farms, necessitating paddock fences at critical points on slopes, often leads the farmer into up-and-down ploughing instead of contour ploughing ; and often to carry a crop type from one slope to the next, from one suitable slope to a steeper, and less suitable slope. Or again he may be forced to maintain summer fallow on land that should not on

* Contribution to the discussion on Soil Erosion at the Canberra meeting of the A.N.Z.A.A.S., January, 1939.

† These matters have been discussed at greater length in University of Sydney publication in Geography, Nos. I and II.

I. " The Meaning of Soil Erosion." II. " The Erosion Pastoral Problem of the Western Division of N.S.W."

any account be left bare, unless protected by a well-covered upper slope. In regions of torrential summer rain and long summer fallowing, acceleration of erosion is most noticeable.

With reference to (3), I will omit discussing arid erosion in view of the subject matter of the next speaker ; nevertheless the essential problem in arid erosion is a false attempt to apply pastoral and agricultural methods characteristic of normal rainfall regions and not arid rainfall regions.

Over-stocking and tramping out in times of plenty, and the ruthless use of land around station buildings, etc., and around townships are cumulatively destructive practices.

If it be true that soil erosion acceleration is man made, then how far can farming practices be altered to bring them into conformity with the *deceleration* of erosion ? Since agriculture depends upon the human betterment of natural processes, any logical methodology must take advantage of the deposition principle in natural erosion—or to put it another way, it is now necessary to ask the farmer to consider his farm economy in terms of soil erosion or rather soil conservation, as well as on a plant productivity basis. This point would seem to be the first step.

The second step is to plan the farm so that certain areas must always remain tree-covered, and with the trees properly arranged in contour belts ; thereafter, other areas must always remain as conservatively stocked pasturage, so as to permit the natural soil disintegration from the upper steep slopes to accumulate on the immediate surrounding slopes ; further away from these, there must be natural drainage channels or road distribution channels maintained in a permanent vegetation cover.

In brief, the first consideration is the survey of each property to ascertain where the natural rain run-off and the natural soil-forming processes combine in the interests of farming economy, and where against it. When that has been done it will be found that the natural processes can be used to promote soil growth and moisture conservation. It would appear then that before much can be done to stimulate soil movement advantageously, there is the necessity to face up to social responsibilities. In the early stages, in view of some supposed fear on the part of the farmer, one is obliged to take the line which is least disadvantageous in case these artificialities of contour terracing, etc., prove worse than the realities.

In soil erosion literature generally, farmers have been admonished as destroyers and users of national capital. It is time to demonstrate by regional councils and regional experiments, and indeed social legislation, that the artificial control of soil movement is as much the farmer's concern as is the growing of wheat. Before the farmer begins artificially to stimulate soil growth, he should have the cooperation of the forester, the land valuer and the road maker.

Retardation of Soil Movement.

It will be sufficient if I now discuss certain examples purporting to retard soil movement. An ancient method, greatly popularised and vastly elaborated in America, is the formation of contour drains or broad-based terraces, but these—if badly constructed—make the cure worse than the disease. The present practice is to provide a drain with a slope of 1½ to 2 per cent. and to place the drains as much as 30 yards apart. I am of the opinion that more frequent shallow drains with a gradient of 1 per cent. is more satisfactory.

Fig. 1.—Examples of Destructive Exploitation of the Soil.

1. Over-clearing and over-stocking on slopes—all top soil removed.
2. Wrong ploughing—clay fractions removed, sand accumulated—loss of fertility.
3. A new channel from a broken and badly constructed contour drain. Note aggravation by up and down ploughing.
4. Destruction of young wheat by siltation—filling up and overflowing of contour drain.

The whole success of contour draining consists in having a very broad shallow front to the drain, and a very broad base to the terrace. In this way gullying will be prevented, though a certain amount of siltation will take place. The aim here is not to stop erosion, for it is almost impossible to stop the entire effect of a typical four-inch rainfall storm, but to throw back the erosion stage from gullying into sheet erosion and maintain it at that. The principle is not to attempt to cure all artificial soil movement, but only to put the soil eroding stage one or more steps further back, and into a stage where it can be controlled.

Again, broad-based terracing has as its object draining water off the land. I consider that the essential feature is not to drain much water off the land, but to so arrange the terraces as to get a better water dispersion and a beneficial redistribution of the separated clay and silt fractions resulting from any rain storm. Indeed it is sometimes possible to take storm water off a road and, in a sense, irrigate neighbouring paddocks. I will not discuss this at length

Fig. 2.—Constructive Devices to Conserve Soil.

1. Destructive collection.
2. Constructive dispersion.
3. Destructive offset of road water into paddock—wire netting and stone work inadequate.
4. Simple divertor, and dispersion channel in rear.
5. Tractor and plough engaged in "contouring".
6. Prolific growth on broad base terraces in field of excellent wheat.

but refer you to the *Australian Geographer*, Vol. III, No. 5 : " The Control of Rain Run Off ", by J. Macdonald Holmes and W. H. Maze.

Again, shallow ploughing has been considered a good Australian agricultural practice, but experiments are now necessary with deep ploughing, and in combination with broad-based terracing. Disc ploughing and continuous working of the soil have greatly assisted in the formation of a hard band in the topmost B horizon. This subsoil hardening in itself is detrimental, but when associated with gullying it has a disastrous effect in promoting cataclysmic collapse of the gully sides. Deep ploughing and broad-based terracing make for better " irrigation ", and a better retention of moisture in the soil with less liability of sheet wash and gullying.

Perhaps the most important aspect is the relationship between soil movement and crop and pasture types. Now whether artificial as crops, or natural as trees and grasses, the vegetation cover and soil are co-existing partners. This has not been fully realised, since pastoral management has been a matter of soil chemistry rather than soil geomorphology. Crop rotation systems have envisaged chemical fertility but seldom soil accretion and still less the maintenance of soil texture and structure fortified against soil movement. The immediate need in soil conservation is a grassland survey which will choose those natural grasses observed to be combating erosion and which also make good animal fodder. Plant breeding from natural grasses for soil conservation purposes is as much a necessity today as was the work of Farrer and others on wheat a generation ago.

This relation between crop pattern and farming practice on the one hand, and accelerated soil movement on the other, is worthy of closer study. Thus we have found that on the Western Slopes country of New South Wales, in the red-brown sandy loam soils, slopes of 2° are critical when in wheat, and that changing to grazing lucerne—as has become fashionable—does not greatly diminish soil movement. It is necessary to strip-farm the whole property to get worth-while results. Slopes of 2° or less can be continuously cropped without much soil change ; slopes of 2° to 4° can be cropped with the help of erosion control, while on slopes of over 4° cropping should not be permitted and thereafter a permanent vegetation cover must be maintained and suitable dispersing channels arranged.

These examples have referred to top soil movement, but equally great movements take place in the subsoils and in the soil deposit as a whole. Complete saturation of a soil deposit may mean enlargement which increases the volume by about one-half. On drying out, rarely does the soil return to its original position. Differential wetting and drying in A, B and C horizons, and between different regions on slopes, produce considerable movement in the whole deposit. Thus soil could often be likened to a carpet overlying a migrating floor—the A and B horizons continually settling on a contracting C horizon. There is now sufficient evidence that soil *moves beneath* the carpet of grass or

plants. Further, the mass movement of soil beneath a hardened AB horizon is considerable. It is here that soil conservation will find its most difficult tasks. For these reasons, knowledge of the past " erosion history " of a deposit is of inestimable value in soil studies, and the climatic history is perhaps even more important than the rock history. In the soils of New South Wales we have recently obtained evidence of several phases of intense soil movement, at least one of which was under arid conditions and two under pluvial.

Now in " Soil Erosion and Its Control ", by Q. S. Ayres (an excellent book likely to be much used in Australia) elaborate methods are described to rearrange soil deposits for erosion prevention. While suitable to American conditions, these methods ought to be used with caution in Australia. The soil deposits in Australia are not suited to much " tearing about ", and much of the erosion is at the stage when " prophylactic treatment " will give better results than " deep surgery ". The promotion of vegetation growth and enhanced crop yields will be most successful when farming adjusts its practices and economy to the critical rate of rain run-off and to soil deposition mechanics.

Selection, Acclimatisation and Production

By

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In the development of agricultural and pastoral production much attention has been devoted to " improvement " of the marketed products ; and in many instances the introduction of foreign types of animals and plants has been necessary to achieve amelioration of quality or increase in quantity. It is recognised practically that certain types are better fitted than others for successful production in some environments, and it is usual to hear that the progressive breeder of animals must choose " the right breed in the right environment ". Such a statement, however, tends to dismiss too summarily major questions involved in the selection of domesticated stock ; at least two questions of considerable practical and economic importance, attending the transference of breeds or types from one environment to another, are obscured : (*a*) how far is the original environment reproducible in the new, and the level of productivity (in the broadest sense) maintained, and (*b*) if the new environment is not closely similar to the original (frequently the case) how far and in what directions will the new form of productivity differ ?

The histories of many of the breeds of farm livestock provide many instances of " improvement " or of changed production in localities other than those which may be called ancestral, e.g. the " Scotch " Shorthorn, the

Australian Merino and the New Zealand Romney. These changes cannot always be attributed solely to deliberate selection, although most of our present " breeds " owe much of their type and productivity to such selection in some artificial (more or less controlled) environment. Even in the pastoral or ranch areas of the world, under extensive conditions of husbandry, some measure of control of environment is exerted or attempted, and in these regions the practical breeder seeks to counter deterioration of type and productivity (relative to the performance of importations) by continuous fresh introductions of more highly selected stock from more favoured areas, where the control of environment is greater. The frequency and amount of these introductions seem to depend often on the dissimilarities of the two environments or on the difficulty of reproducing practically and economically that general environment from which the introductions originate, or again on the suitability of the imported genotype to its new environment, i.e. to depend on the answers to the above questions.

The progressive breeder attempts, through trial and error, to import that genotype (breed or strain) which reaches the most suitable expression in his own local environment, but the direction and purpose of deliberate selection having altered in the original homes of many domesticated breeds, he is often presented with a great array of types from which to choose ; and skillful husbandry in the form of feeding and management having contributed to establishing those types, his problems have increased.

Australia's Foundation Stock.

The foundation stock of the domesticated animal of Australia were all imported ; and in the Australian Merino sheep many distinct types or strains have become established according to (*a*) original foundation stock, (*b*) trend of selection, and (*c*) local environment. But the various types can be, and for practical purposes are, conveniently grouped according to area of origin, i.e. the local environment of the stud flocks, e.g. the South Australian strongwool studs, the New South Wales (Riverina and Western Plains, etc.), the Tasmanian finewool, the Victorian (Western District) finewool, etc., with further subdivisions according to precise origin or parent stud.

A general conclusion to be drawn is that the direction which selection, by culling and deliberate mating, has followed has been largely determined by local environment, that is, a certain genotype has only been established where local conditions have led to an appreciable expression of a particular phenotype. The progeny test is widely applied, but the limits of selection are largely those imposed by the local environment and within the phenotypes favoured by it.[1]

But the great numbers of commercial flock sheep are much more widely distributed than are the aggregations of the parent stud flocks and, with dispersion, the variations of type, i.e. of growth rate, size, wool character, hardiness, fertility, etc., are manifold. In Western Australia the stud flocks

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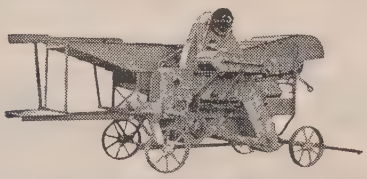

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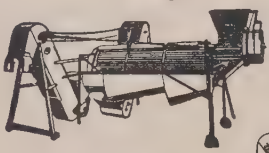

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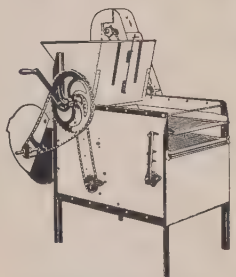

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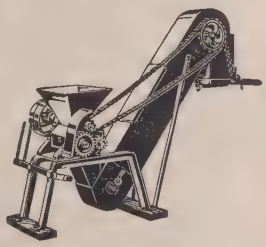

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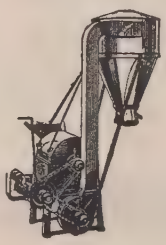

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are derived largely from South Australian and Riverina or New South Wales parent studs, the pastoral area flocks from the local studs or from the parent studs direct, but a characteristic tendency so far as wool production is concerned has been towards a somewhat finer, lighter fleece and in body size to a smaller sheep. The type imported by a pastoralist may be influenced by personal preference or by financial facilities as well as by experience, but from observations being made from this Institute certain features of the problem can be recognised which tend to emphasise the importance of taking environmental factors into account.

The concentration of stud flocks has largely occurred in areas where it is possible to " do the stock well ", thus the difference has widened between the conditions under which pedigree or line breeding is pursued and those where commercial wool production is expected. In stud flocks, selection has frequently been dictated by competition with other stud flocks in similar fortunate circumstances of environmental control, especially of nutrition ; and in these cases full cognisance is taken of the somatic characters better expressed under those advantageous conditions. In other cases, however, the deliberate policy is to select for a type of sheep which experience shows to be successful under the poorer, less advantageous conditions of the pastoral areas. In the former, selection is towards a better animal in a good environment, in the latter, towards a better animal for a poorer environment ; and the results may be entirely different not only in the initial circumstances but also when the stocks are taken to less favourable areas.

The Progeny Test.

The selection by the progressive or constructive breeder is often confused by what is largely environmental, and where the progeny are to be called upon to produce in more adverse (less artificial) environments, a progeny test *there* is possibly of greater value than one under more congenial surroundings, assessing with more accuracy the genotypes for such physiological characters as constitution, fertility, growth, fleece form, milking capacity, etc.

With domesticated stock economical production apparently requires an improvement of environment towards that in which the productive genotypes have been selected so that they may be used or, where this improvement is not practicable (e.g. in many of the extensive pastoral areas), a selection of genotypes *for* if not *in* the more adverse conditions. A combination of these requirements may be necessary, but in any case further analyses of environmental effects and the reactions of different genotypes would seem very desirable before a reorientation of selection may be proposed.

Reference.

(1) Nichols, J. E. : " A Study of Empire Wool Production ", Wool Industries Research Association Publication, 1932. Emp. J. Exp. Agric. 3 : 21-24 (1935).

Aerial Wells

By

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The purpose of this note is to draw the attention of Australian agriculturists to a method of extracting water from the air, which has been described in other countries. While the practical importance of this method may be slight, an experimental test could easily be carried out.

An " aerial well " consists simply of a pile of stones, protected from the sun's radiation by a roof and walls through which holes are made so as to allow free movement of air between the well and the outer air. The bottom of the well is solid except for an opening through which the collected water may be drained away for storage. The wells are said to be used in countries bordering on the Mediterranean Sea, where the summers are hot and dry and there may be no rain or dew of any importance for months at a time.

I know of only one English account of these wells.[1] The best reviews of the subject are in French, and of these the most useful is an article by Chaptal.[2] We are told that a " well " 3 metres square at the bottom and $2\frac{1}{2}$ metres high in the form of a truncated pyramid, containing stones between 5 and 10 centimetres in diameter, produced up to 2 litres of water in a day, and a total of 87 litres (the equivalent of about 40 points of rain) in six months. A thousand-gallon tank on this basis might produce about 5 gallons in January and February in Australia.

Although the amounts of water concerned are small, the whole idea at first seems incredible, especially when we learn that the water is collected during the day—in fact, some of the best flows occur on the hottest days. One naturally thinks first that this water is dew, but the contribution made by dew must be very small, since the temperature of the stones is often well above the dew-point of the air for several successive days while water is being collected. Now it is found that water is gained in greatest amounts when there is a marked increase in temperature from night to day. For example, the following conditions, which represent a typical hot day in southern Australia, appear to be good for the collection of water :

Time.	Dry Bulb. ° F.	Wet Bulb. ° F.	Absolute Humidity. Inch.	Relative Humidity. Per cent.
4 a.m.	60	54	0·337	65
3 p.m.	100	70	0·329	17

The absolute humidity stays fairly steady during the day, while the relative humidity drops sharply. This change in relative humidity suggests the following explanation (if we accept the reports) :

Just before sunrise the stones of the well have reached equilibrium with air of relative humidity 65 per cent. Water vapour from this air condenses on the surfaces, in the state of hygroscopic water with which text-books on soil have familiarised us, the amount of water that can be thus held being fixed for every material by the temperature and the humidity.

After this equilibrium is reached, the stones come into contact with air of steadily decreasing relative humidity, falling to 17 per cent. in the afternoon. Much less water is held by the stones at this lower humidity than at the higher, so that some of the water that was fixed during the night is free to move, either in the form of vapour (in which case it moves outside the well and is lost) or as liquid water which can trickle down to the bottom of the well and so be collected. If we neglect the amount of water lost as vapour, and assume that the stones are spherical, we can calculate that the condensation of water necessary to produce a flow of 2 litres would necessitate a film at sunrise about 3 microns thick. This is at least ten times the thickness of an adsorbed layer of water on glass wool, and is only credible if we suppose that the inner surfaces of the pebbles are at least ten times the size of the visible surface. If 50 per cent. of the water is lost as vapour, the necessary thickness of film will of course be doubled.

This effect cannot take place if colloidal matter is present, and is therefore not found in normal soils. During dry weather in which no dew forms, the amount of moisture held in the top three inches or so of the soil rises each night and falls each day ; but the water that is gained in the night cannot trickle down during the day into the cool subsoil since it is still too tightly held by the colloidal material. The effect of the aerial well, if it is valid at all, must be confined to pure sand and gravel.

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(1) Imp. Bur. Soil Sci. Monthly Letter No. 46, 1935.
(2) L. Chaptal. Trans. 1st Comm. Internat. Soc. Soil Sci., 1934, pp. 205-207.

Virus Activity as a Property of Some Protein Molecules*

By

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Waite Agricultural Research Institute, University of Adelaide, South Australia.

The inclusion of this subject in a symposium on the relation between chemical constitution and biological activity seems to imply a greater knowledge of viruses than we have. It seems to be a few years ahead of its time because as yet we know very little about the chemical structure of viruses, and I do not propose to say much about that. However, all those viruses which have been obtained in a pure state have been found to be proteins, and if we regard the protein molecule as a whole as a structural type, then my subject fits into the symposium well enough. It is also fairly certain that studies of the relation between the chemical constitution of these virus proteins and the similarities and differences shown by them, especially in the case of mutant forms, will add very materially to our knowledge of the relation between chemical constitution and biological activity in its widest and deepest sense.

A virus may be defined very briefly as a " submicroscopic " thing which is capable of multiplying in living tissues and there may cause a characteristic disease.

Viruses undoubtedly have *biological activity*, and it is because of this that their presence is made known. In the reactions which we observe *in vivo* the host plays a part as well, but the biological activity which is common to all viruses and is of the greatest importance is their power to multiply in living tissues.

Besides this power to multiply, viruses have other properties in common with acknowledged living organisms, the chief one being the power of some viruses to undergo spontaneous mutation, that is to change to a new form which then perpetuates itself and " breeds true ".[1, 2, 3, 4, 5] Apart from this type of change the passage of a virulent form of virus through different hosts or through a different type of tissue in the same host often results in the virus being modified to such an extent that it becomes a mild strain. The transformation of smallpox into vaccinia is a case in point. The reverse process of modifying a mild strain to a virulent one is not so common, but the virulent form of the virus of curly top of sugar beet, for example, is modified to a mild strain by passage through either a species of *Chenopodium* (a weed of almost

* Paper presented at a symposium on " The relation between chemical constitution and biological activity " at the Canberra meeting of the A.N.Z.A.A.S., January, 1939.

universal distribution) or a tolerant sugar beet which acts as a symptomless carrier. The virulence of this mild strain may be restored by passage through chickweed (*Stellaria media*).[6, 7]

Because of their similarities with microorganisms, the study of viruses was for many years confined almost entirely to biologists, with the natural result that those properties which viruses had in common with microorganisms were emphasised.

However, there was always some doubt about the amount of organisation that would be possible in things as small as some of the viruses appeared to be ; and these doubts were reinforced when the improved technique of ultra filtration developed by Elford and others, and applied to plant viruses by MacClement and Henderson-Smith, Kenneth Smith and others, revealed that the smaller viruses had apparent diameters as small as 10 or 15 mμ—that is 100 to 150 Ångström units.[8, 9, 10, 11, 12]

Chemists then became interested, first in plant viruses, and before long the *type* virus—the one responsible for ordinary tobacco mosaic— was obtained in a pure state by chemical means and was identified as a protein.[13, 14, 15, 16, 17, 18, 19, 25] Subsequently about eight other plant viruses, at least two animal viruses,[20, 21] and one bacteriophage[22] were shown to be proteins also. So far as I know, nothing further has been published on the chemical characteristics of the animal viruses—that is apart from their identification as proteins, which of course included a figure for the nitrogen content. And so in describing some of the properties of viruses I propose to restrict myself to plant viruses and particularly to tobacco mosaic virus.

All the plant viruses so far isolated contain nucleic acid as an essential constituent. Their qualitative chemical and physical reactions and their percentage composition in respect to C, H, N and P are similar to those in normal nucleoproteins ; C=50, H=7, N=16½.

Three strains of the tobacco mosaic group of viruses and two strains of potato X virus contain about one half per cent. of phosphorus and two and a half per cent. of carbohydrate of the ribose type. Tomato bushy stunt virus contains C, H and N in about the same amounts but contains two to three times as much phosphorus and carbohydrate, that is it contains more nucleic acid.[19]

Apart from the evidence of X-ray analysis which I shall deal with later, we know practically nothing about the structure of the individual proteins ; there has not been time to do much yet. But there seems to be no reasonable doubt that virus activity is a property of the protein molecule as a whole.

It is necessary of course to establish as well as possible that the protein and the virus are one and the same thing. We may consider ordinary tobacco mosaic virus from this point of view because more work has been done on it than on any other virus, and the results obtained in the United States, in England and in South Australia mutually support each other.

In the first place, no protein of this type has been obtained in healthy plants ; and the introduction of less than a hundredth of a milligramme of the protein into a single plant results in the production of one gramme of recoverable virus protein in a matter of a few weeks. The whole of the infectivity of the expressed juice of diseased plants is associated with this protein. Any treatment, chemical or physical, which denatures the protein also destroys the infectivity. All attempts to separate the protein into infective and non-infective fractions have failed. The methods used have included many which have been successfully used in detecting inhomogeneity in solutions of normal proteins. (Svedberg's ultracentrifugal technique which has been used to separate into three fractions a serum globulin which for years had been regarded as a single protein species, has demonstrated only one molecular species in carefully prepared tobacco mosaic virus preparations.) Moreover, the infectivity per unit weight of protein is the same for preparations derived from different plants and at different times of the year. Table 1 illustrates this for four preparations which were derived from four harvests covering a period of about twelve months.[23]

TABLE 1.

Ordinary Tobacco Mosaic Virus.

Comparative infectivity tests of pure virus protein prepared from different sets of plants at different times over a period of 12 months.
Virus concentration of all inocula $= 1 \times 10^{-6}$ gm. per millilitre.
Infectivity determined by the number of primary lesions on *Nicotiana glutinosa* leaves (whole leaf, incomplete block comparisons).

Virus Sample.	*Comparative Infectivity.*	
1	100	No significant differences.
2	105	
3	89	
4	101	

The infectivity figures are the same for all preparations within the accuracy obtainable by the primary lesion method. In fact all the evidence at present available leads to the conclusion that the protein is the infective principle, and there is no evidence to the contrary.

The physico-chemical properties of some of the plant viruses are rather interesting. Seven of them have been obtained in a paracrystalline or liquid crystalline form, and one of them in the form of true crystals.[24] The photographs* of Figures 1 and 2 illustrate some of the paracrystalline properties of ordinary tobacco mosaic virus. Figure 1[16] shows the appearance of the individual fibres under a polarising microscope ; they show spontaneous double refraction with straight extinction. An interesting property of the fibres is their reaction to heat. At 90° C. they collapse and form irregular clumps, and this temperature is also the thermal death point of the virus. The identity of the temperature at which the virus is killed and the fibres lose their structure seems to me to be very significant. Figure 2 consists of photographs in

* Photographs reproduced in this paper were taken by Mr. A. D. Cocks.

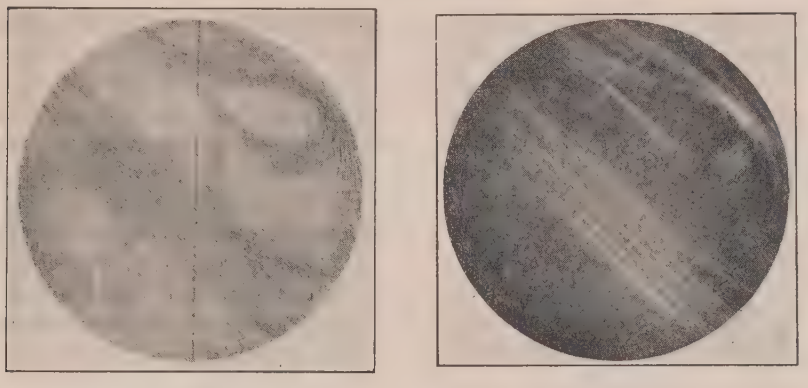

Fig. 1.—Paracrystalline fibrous aggregates of tobacco mosaic virus.
Left: Ordinary light. *Right*: Between crossed nicols. (× 90.)

ordinary light, and between crossed polaroid screens, of a 1·8 per cent. virus solution which has separated into two phases. The upper phase is isotropic unless disturbed, and the lower one is spontaneously birefringent. Bawden and Pirie consider that the " layering " is due to impurities and that if it were possible to get an absolutely pure solution we would get either one or the other layer, but not both together. My own observations, however, indicate a definite relationship (at constant temperature and pH value) between the relative proportion of the two phases and the concentration of virus and electrolyte. Figure 3 illustrates this relationship.[23] The shaded portion indicates the zone over which the two phases appear to co-exist in equilibrium.

Sir David Rivett has drawn my attention to the similarity between this behaviour and that of McBain's soap systems.[26] The general similarity is

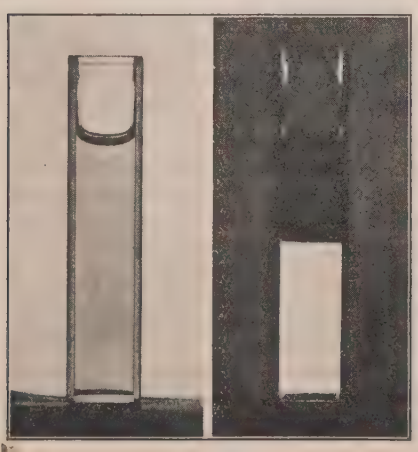

Fig. 2.—A solution of tobacco mosaic virus which had separated into two phases.

Left: Photographed by ordinary transmitted light.

Right: Photographed between crossed polaroid screens.

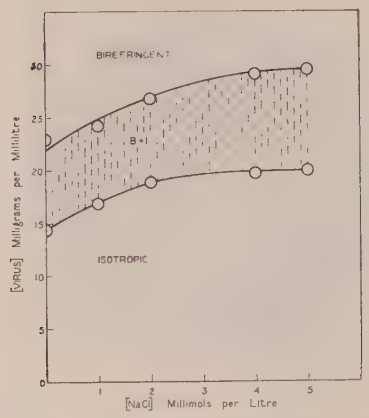

Fig. 3.—Relationship between concentrations of NaCl and virus in phase separations in the system: tobacco mosaic virus—salt—water (pH7, 30°C.).

quite strong, but it would be premature to say much more at present. There also appears to be some resemblance to the behaviour of old vanadium pentoxide sols. The outstanding thing is that in those properties which I have just described and in all its *in vitro* reactions, solution and precipitation, gel formation, its coagulation by various electrolytes to give a lyotropic series,[27] and so on, it behaves like an ordinary chemical system.

Bernal's brilliant X-ray investigations[18, 28, 29] have further emphasised the similarity between these viruses and ordinary proteins, in so far as their internal structure is concerned. Using oriented material, Bernal obtained two types of diffraction pattern—due to low angle and high angle diffraction respectively. The former varies with conditions (such as the concentration of virus) and is due to the spacing between particles. The latter is constant and is due to the internal arrangements of the virus molecule itself.

Bernal draws two definite conclusions:

(1) That the separate virus particle has an internal crystalline structure of great regularity; and

(2) that this structure is analogous to that of other crystalline proteins.

So far actual dimensions published have been provisional only, pending a more careful analysis of the patterns, but for our purpose the provisional ones will serve quite well. The molecule is composed of sub-molecules of about 22 Å. × 20 Å. × 20 Å., each of which consists of sub-units of about half these dimensions. The molecular weight calculated by Bernal from the volume estimated in this way and the experimentally determined density of 1·3 is 41,000.

All eight viruses so far examined give intra-molecular patterns of the same general type, but the differences which do exist and the differences of the intermolecular patterns lead to a classification which agrees in all respects with that arrived at from the observations of botanists and serologists.

The evidence for the protein nature of this group of viruses is so overwhelming that in any discussion on the subject the onus of proof now rests on those who maintain the contrary. This basal fact having been established, the next and certainly more difficult, and on that account more interesting, task is to find out the cause of the differences between various viruses. Presumably these are due partly to different prosthetic groups on the virus molecule,

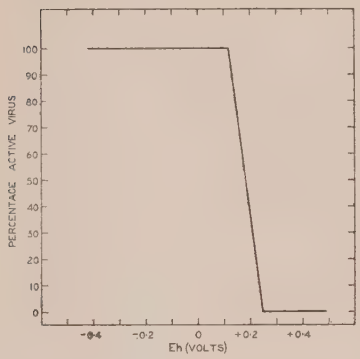

Fig. 4.—Effect of redox potential on the virus of tomato spotted wilt in vitro at pH7.

and partly to different arrangements and proportions of the common constituents.

We have only to contrast the properties of such viruses as tobacco mosaic and tomato spotted wilt to realise that they must have very different active groups.

Tobacco mosaic virus remains active in solutions exposed to air for many years, whereas that of tomato spotted wilt becomes inactive in a few hours. Although tomato spotted wilt virus has not yet been obtained in a pure state, its properties have been studied in the presence of other juice constituents, care being taken to arrange the experiments in such a way that any effects on the virus itself may be readily interpreted as such.[30, 31] The short *in vitro* life of tomato spotted wilt virus is due to its extreme susceptibility to oxidation. Figure 4 shows how the oxidation reduction potential of the medium affects the activity of the virus *in vitro*. (The curve was obtained by adding virus to solutions of suitable redox systems and comparing the virus activity at various times with untreated controls. In the case of the more positive systems inactivation was almost instantaneous but the curve was drawn on the basis of a four-hour contact between virus and medium.)

By suitably adjusting the pH value and maintaining reducing conditions, the *in vitro* life of this virus has been extended from a few hours to just over one month.[31]

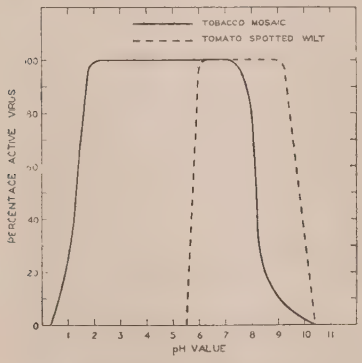

Fig. 5.—Relationship between pH value and the in vitro activity of the viruses of tobacco mosaic and tomato spotted wilt.

In regard to reaction to chemical treatment, tobacco mosaic virus is particularly resistant. It is not affected by those mild oxidising agents which, even at a concentration of one-ten thousandth molar, inactivate the virus of tomato spotted wilt. (It is, however, slowly inactivated by stronger oxidising agents, and substances like permanganate, which oxidise almost any organic matter, also inactivate it.[32, 30])

The activity pH curves[33, 34, 23] of these two viruses also differ markedly. This is shown in Figure 5. (The shape

of the curve for tobacco mosaic virus on the alkaline side resembles that of the neutralisation curve of a weak acid.)

The serological behaviour of viruses is also of interest. Most plant viruses act as typical antigens. That is, they produce antibodies when injected into animals such as rabbits, and the antiserum containing these antibodies will precipitate the virus from its solutions.[35, 36] Now it is possible by mild treatment with hydrogen peroxide, formalin, nitrous acid and by irradiation with ultra-violet light to inactivate some of these viruses without in any way altering their antigenic behaviour.[37, 38, 39, 40] The inactivated virus is still capable of producing antibodies and of reacting with antiserum. The particular chemical groupings which are responsible for the antigenic behaviour are evidently distinct from those which are the seat of the infectivity. But treatments which cause the denaturation of the protein also destroy the antigenic properties of the virus as well as the infectivity. It seems very likely that infectivity may be lost by the molecule, either as a result of action on specific active groups which one infers from the general behaviour of the viruses, or as a result of an action on some generalised part of the protein molecule. The nitrous acid treatment, for example, removes the free amino groups. It is not likely that all the inactivants have the same chemical action.

Some of the reactions which cause inactivation appear to take place in two or more stages. The pH activity relationships for tobacco mosaic suggest this, and it has been possible partially to reactivate virus by changing the pH value back to the optimal range.[33] This reactivation is only possible while the inactivation process is in progress, and once the inactivation reaction has reached its steady value no reactivation has been possible. Recently the same sort of thing has been observed with formalin treated virus, in which parallel changes in the free amino groups have been demonstrated.[41]

To sum up, there can be no reasonable doubt that a number of viruses are nucleoproteins. What particular constitutional features distinguish them from the non-self-multiplying proteins we do not know. For that matter we still do not know very much about the *in vivo* synthesis of ordinary proteins and whether or not some of them are self reproducing. In fact, our state of knowledge of the whole matter is such that we are justified in indulging in a certain amount of speculation in the hope that it might lead to hypotheses which may be put to the test of experiment.

We may assume some common factor in the structure of viruses to account for the common property of self-reproduction. The common factor will probably be the general arrangement of the protein molecule as a whole, and may include a common prosthetic group or groups. Slightly different arrangements within the main molecule may give rise to different virus types. The evidence for this view comes from the X-ray patterns. Certain differences in the patterns between tobacco mosaic and potato X are interpreted by Bernal

to indicate similar sub-units arranged in a different way. We would expect such differences to be accompanied by differences in the active surface groups.

The difference between strains of the same virus type are probably due to different active surface groups. It is quite conceivable that some of these may be altered or destroyed or that new groups may be incorporated either from without or by slight intra-molecular rearrangements, without affecting the reproductive power of the molecule as a whole. The reactions which might lead to strain variation, adaptation and mutation can be readily imagined on this basis.

We still require a picture of the possible method by which a virus multiplies. On the available evidence it is extremely unlikely that the virus multiplies at the expense of raw materials produced by breaking down more complex units such as chromosomes or other nuclear material. For one thing the carbohydrate of the nucleic acid of chromatin material is a desoxy-pentose whereas that of tobacco mosaic virus has been shown by Bawden and Pirie to be a ribose.

I shall conclude by giving a brief summary of a possible mechanism which I have put forward on previous occasions to account for this reproduction. We may regard the virus molecule as a sort of template. By virtue of its surface electronic forces it would attract to its surface from its environment the essential building blocks which go to make up its structure. These may consist of amino acids as well as of simpler and more complex materials, some of which may well be intermediate compounds which have only a transient existence during normal metabolism. As each block is assembled the surface forces would of necessity be rearranged, and so the process would go on until an exactly similar molecule is built up. The fact that the molecule has depth as well as length and breadth, and is more than a mono-molecular sheet, does not present any difficulty because once the first layer is laid down the others are built on automatically. In this case the replica is a part of the parent molecule until it is complete. Even then it may repeat the process and reproduce itself without breaking away from the parent. It is also possible that the virus molecule has analytic as well as synthetic powers, and in this sense it would in part be producing some of its own raw materials and environment. It is possible that conditions in this environment* (due to causes external to the virus) may be such that a building block here and there may be slightly different from the standard pattern without detracting from the power of the molecule to multiply. This would readily explain the occurrence of mutations and strains and variations caused by passage through different hosts.

It is one of the main problems of the future to determine what structural arrangements underlie the infectivity and powers of self-reproduction of

* Such as changes in the relative or absolute concentrations of various amino acids, etc.

viruses. But whatever the true explanation may be, the solution of this and allied problems demands the close co-operation of physicists, chemists and biologists of all kinds.

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TECHNICAL NOTES

A PROTEIN "SURVEY" OF THE SOUTH AUSTRALIAN WHEAT BELT.

Dissatisfaction with the standard of quality of the f.a.q. samples of wheat from Australian States, and the demand in many quarters for a more comprehensive grading system, necessitate an attempt to determine the potentialities of the various States as producers of premium wheat.

The cooperation of farmers throughout the South Australian wheat belt was enlisted in 1934 and again in 1936, to ascertain the amount of premium grain which might be produced by that State in a normal season.

In 1934, samples of a pure line of the variety Ford were forwarded to 600 farmers, to be seeded under field conditions; and in 1936 the four varieties Ford, Dundee, Ranee and Gluwari were sent to 200 farmers. All centres of the wheat belt were represented. Each lot of seed was sown through the drill or combine in a field of the farmer's own crop.

Heads of each variety were snipped off at maturity and returned to Roseworthy College, where they were threshed and the grain tested for crude protein content, milligrammes of anhydrous maltose produced per ten grammes of flour by the Rumsey procedure, and for gluten quality as assessed by the wholemeal fermentation time test. Samples were bulked according to protein percentage, and baking studies carried out.

The crude protein content is of most importance for the reason that the value of any grade of wheat for bread-making is based primarily upon the percentage of protein it contains.

Until it has been demonstrated that any one State of the Commonwealth can produce a large amount of grain with a relatively high protein content, proposals for a more complex grading system in that State will find little support.

Range in Protein Content.

In the season 1936, the range in crude protein content for the four varieties was:

Ford	6·79-18·95%
Dundee	7·13-18·87%
Ranee	8·16-17·30%*
Gluwari	7·75-16·87%*

From fifty centres taken at random, the average protein content for the four varieties was as follows:

Ford	14·02%
Dundee	13·02%
Ranee	13·06%
Gluwari	12·84%

* 50 centres only.

With the exception of Ford, all varieties are of approximately the same maturity, and it is interesting to note that their powers of protein elaboration were not significantly different. Ford, being later maturing than the other three, might be expected to return grain with greater, equal or less protein, according to the season.

Factors Affecting Protein Content.

Bailey[1] summarises work performed on this subject prior to 1924, and the consensus of opinion is :

(1) The hotter and drier the weather, the higher the crude protein content of the grain.

(2) The lower the percentage of moisture in the soil, the higher the protein content.

(3) Seasonal conditions are much more important in their effect upon protein elaboration in the grain than is the chemical composition of the soil.

Swanson,[3] however, states emphatically that the protein content of the grain depends entirely upon the nitrate nitrogen content of the soil, and that climate is important only in that it affects the yield as related to the original nitrate nitrogen content of the soil and the rate of formation of nitrate nitrogen in the soil.

Briccoli,[2] in a European survey, supports the main contentions propounded by Bailey. The evidence obtained from the present surveys also substantiates the findings of these workers. Swanson's theory held good with the majority of cases but there were many anomalies.

The protein content of samples from the various districts closely approached what might be expected from a study of climatic conditions. Samples with a high protein content were received from centres which experience a low rainfall combined with high temperatures during the ripening period. The Far West Coast and Upper Eyre's Peninsula, the hot dry plains east and west of the Flinders Ranges, Skilly and Barossa Hills, the Upper Northern agricultural area and most of the Murray Mallee, all returned samples in both years with a protein content of 13 per cent. or more. There were few exceptions. " Low protein " districts included the lower Eyre's Peninsula, the more favoured regions of the central and northern agricultural areas, the upper south-east and County Buccleuch in the Murray Mallee. Throughout most of this county the subsoil is very retentive of moisture, and in spite of high temperatures the crops ripen steadily.

Protein figures were reasonably constant over fairly large areas in which climatic conditions did not vary, in spite of fluctuations in soil type, farming methods and time of planting. Fluctuations within districts were most noticeable where the topography varied, for in South Australia there is a close association between climate and topography.

The Theoretical Production of Grain with High Protein Content.

On the basis of the average yields of each district for the seasons 1931-32 to 1935-36, it was estimated that South Australia should be capable in a normal year of producing 20 million bushels of grain made up of lots with a protein content of not less than 12 per cent. In dry years there would be an extension in the areas capable of producing high protein grain, but this would be counterbalanced by a corresponding reduction in yield; in wet years a decrease in area would be counterbalanced by increased yields. Only in very dry or very wet years should the estimate of 20 million bushels be substantially reduced.

Protein Content and Kernel Texture.

A pleasing feature of the survey was a substantiation of the opinion that protein content is associated with kernel texture. Studying the vitreous grained variety Dundee, it was apparent that the presence of mottled grains or " yellow-berry " in a sample denoted low protein content, and the absence of this condition was a reliable indication of moderate to high protein content. There was also an association between the degree of mottling and protein content. This is illustrated in Table 1.

TABLE 1.—*Illustrating Association of Protein Content with Kernel Texture.*

Visual Observation of Grain.	Percentage of Mottled Grain.	Average Protein Content (%) of Class.
Badly mottled. Grains dull yellow, a number showing small vitreous patches	88	7·9
Considerably mottled. Large yellow patches on vitreous grains	58	9·0
Yellow spotting on vitreous grains	50	10·0
Very slight mottling. Yellow spots small but distinct	25	11·5
Grain hard and flinty but skin with a smoky appearance denoting thick bran	0	14·1
Grain hard, bright and flinty with thin bran..	0	14·2

Only six out of the 120 samples included in the last two classes of Table 1 had a protein content of less than 12 per cent. and then only slightly so. Baking tests with samples of varying protein content demonstrated very clearly the progressive superiority of loaves made from grain with increasing protein content.

These results support the feasibility of a grading system for wheat on the basis of kernel texture. Such a grading system would not, of course, be an economic proposition until wheat breeders had combined vitreous grain with high yielding ability. Those vitreous grained wheats, such as Baringa and

Gullen, which have a baking quality not typical of vitreous wheats, would have to be taken out of cultivation if the standard of a premium grade were to be maintained.

If vitreous grained varieties were grown universally throughout the "high protein" districts, it would not be a difficult matter to bulk or stack and market such grain separately.

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A SEPTORIA SPOT DISEASE OF CITRUS

In 1899, McAlpine[1] described a brown blotch of the lemon from Victoria, naming the associated organism as *Septoria depressa*. He regarded the fungus as being different from *S. citri* (Pass.) and *S. glaucescens* (Trabut). No infection experiments were carried out to determine the pathogenicity of *S. depressa*, and unfortunately no photographs or herbarium specimens of the disease are available.

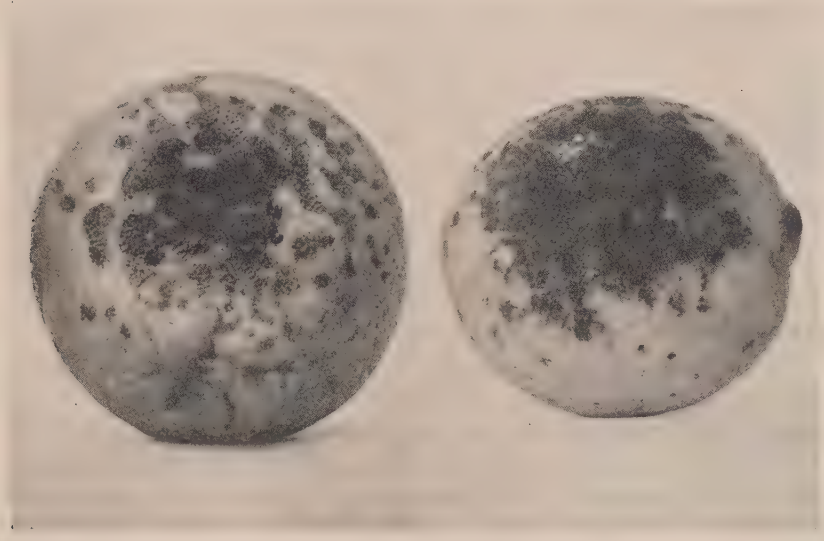
No further references to this disease appeared until 1922, when Osborne and Samuel[2] reported *S. depressa* on *Citrus aurantium* from South Australia. From New South Wales, Noble,[3] in 1932, reported a species of Septoria, probably *S. depressa*, on the fruit and foliage of oranges and lemons. No other species of Septoria have been found on citrus by Australian workers, although *S. citri* is reported to have been found on citrus imported from Australia to U.S.A. in 1935.[4]

In 1930, Adam[5] described the symptoms of a Septoria spot of oranges from Victoria; and later, when commencing work on the control aspects of this disease, submitted specimens to the Imperial Mycological Institute for identification. After a detailed study, the Institute found it impossible to be certain that Adam's fruit-spotting Septoria was identical with either *S. citri* (Pass.), *S. limonum* (Pass.), *S. glaucescens* (Trabut), or *S. depressa* (McAlp.).

The author, in studying the blemishes of citrus fruit in 1935, encountered a Septoria on the fruit of oranges, lemons and grapefruit, and submitted cultures from the former two hosts to the Imperial Mycological Institute, where they were identified with a new species, *Septoria citricola*, described from oranges by

Ruggieri in 1935.[6] It was suggested, however, that the fungus resembled *S. depressa* (McAlp.) and that it was possible that this was the prior name of the species.

In searching the literature on the Septoria spots of citrus to determine whether *S. depressa* or any other species had a right of priority over *S. citricola*, the author encountered many more difficulties and finally concluded that the problem must remain unsolved pending a detailed comparative study of these diseases with special reference to the host range of the various pathogens. The published descriptions of the fungi are, in themselves, of limited value because of the fact that the ranges in size of the spores and pycnidia for a single



Citrus fruits showing Septoria Spot Disease (collected at Rochester, Vic.).
Left: Orange. *Right*: Lemon.

specimen may be just as great as those which exist between two different species. A further difficulty is encountered in determining whether or not such narrow spores are septate.

The fact that a species sporing freely in culture may give rise to non-sporing variants must also be considered. Non-sporing variants, similar to those studied by Hansen,[7] have frequently been obtained in isolates from Victorian oranges and lemons. In this regard it is interesting to note that at the Imperial Mycological Institute the culture of *S. citri* with which the Victorian isolates were compared, was sterile. Although the isolates from oranges appear to be morphologically identical with those from lemons, constant differences in the discoloration of the potato-dextrose agar medium have been noted, suggesting

that they are two strains of a single species. Cultures from oranges always produce a vinous purple discoloration, while those from lemons always produce an olive green colour in the medium. It would be interesting to know if this difference is correlated with a difference in pathogenicity.

The accompanying photographs show the characteristic spotting of Victorian oranges and lemons. However, with oranges, atypical spots—larger and more clearly defined—have been noted, usually associated with rind injuries. The symptoms are unlike those figured in Fawcett's book, which were the only other photographs of Septoria on citrus available for comparison.

Department of Agriculture,
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A. T. Pugsley.

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STRAWBERRY NOMENCLATURE.

Whilst stocks of most pome and drupe fruits correctly named are now obtainable from recognised nurserymen throughout Australia, the position in regard to berry fruits appears to be very far from satisfactory.

Probably the main reason for this is that, with the exception of Tasmania, berry fruit culture cannot, for climatic reasons, be practised on a general scale in Australia. Commercial areas in other States are therefore more or less confined to elevated areas with higher rainfall in isolated centres. This has resulted through time in the adoption of local names for those varieties or strains grown, and named introductions have apparently taken on new habits under the altered conditions and have gradually lost their identity.

Work in Tasmania.

Recent work undertaken by the Tasmanian Department of Agriculture in connection with virus in strawberries has brought the writer into close touch with strawberry nomenclature, and a few instances might be quoted which would serve to emphasise the present chaotic position.

As a preliminary step, a collection of outstanding varieties and strains cultivated commercially in Tasmania was assembled and it was soon evident that nomenclature here was exceedingly mixed. Generally speaking those who supplied named varieties did so in the belief that these were correct and

in confirmation quoted the grower or nurseryman from whom they were obtained, and in several instances supplied invoices. It was thought that the position might be cleared by obtaining plants direct from mainland sources, and accordingly the necessary steps were taken. Results, though surprising, were not entirely unexpected. In a number of the well-known older varieties some of the samples obtained were definitely wrongly named, but no mixed lots were recorded. With the less known varieties, however, in the absence of any accurate descriptions the first difficulty was to discover what were the distinctive characteristics of the original true representatives of any particular named variety, and only in a few instances (for example Mason's Immense) did plants obtained from different centres correspond.

Although another season's observations will be necessary definitely to confirm preliminary records, it is already evident that not only have several distinctly different varieties been supplied under the same name, but several different names have been given to samples of the same variety. At the present time, five differently named " varieties " under trial from New South Wales, Queensland, Western Australia and Tasmania are growing in adjacent rows for comparative purposes, as practically no differences were apparent in the initial trials last year.

Classification System Needed.

Incorrect nomenclature is by no means confined to strawberries ; gooseberries and to a lesser extent black currants and raspberries have required considerable attention in work carried out here, and a numbering system had to be used in recent tests.

A classification system for the different fruits, similar to that adopted at research stations in England, would prove of great benefit if adopted throughout Australia and modified to include commercial varieties now under cultivation here. Following general agreement this could be carried a step forward by the certification of nursery stocks. It is realised, of course, that in several States berry fruits are comparatively unimportant and nurserymen hold only very limited stocks ; nevertheless uniformity is most desirable in the matter of variety nomenclature.

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The Australian Institute of Agricultural Science

MEETINGS OF COUNCIL.

March Meeting.

Held in the School of Agriculture, Melbourne University, on March 16, at 8 p.m. *Present :* Dr. H. C. Forster (W.A.), Messrs. W. B. Miller (Q. and proxy for Mr. J. Brake (V.)), G. W. Leeper (A.C.T.), J. L. Gillespie (N.S.W.), Geddes (T.), the Hon. Treasurer, Mr. R. L. Twentyman, and the Hon. Secretary, Mr. A. J. Vasey. Mr. R. D. Croll was present by invitation. Mr. Miller occupied the chair.

Mr. R. D. Croll was appointed Assistant Hon. Secretary, his duties being to afford general assistance to the Hon. Secretary, more particularly in the prompt preparation of minutes of Council meetings.

The Council accepted the recommendation of the last meeting that Mr. G. de V. Davis should be appointed a delegate from the Institute to the International Agricultural Conference at Dresden, and decided also that the Secretary should write to Mr. Strickland, of the S.A. Branch, offering him a similar nomination for this conference.

The Secretary read a letter from the Treasurer, referring to a communication from the auditors pointing out the need, under the provisions of the Companies Act, for a public officer with whom the Income Tax Office shall communicate regarding taxation matters. The Treasurer suggests the appointment of Mr. W. M. Scott, who has expressed his willingness to act in this capacity.

The Secretary read a letter from the Federal President, Professor R. D. Watt, suggesting that the Hon. Gen. Secretary at once inform the Government that the services of the Institute's members would be available in the event of a national emergency.

April Meeting.

Held in the School of Agriculture, Melbourne University, on April 20, at 8 p.m. *Present :* The President, Professor R. D. Watt (in chair), Dr. B. T. Dickson (A.C.T.), Dr. A. E. V. Richardson (S.A.), Dr. H. C. Forster (W.A.), Messrs. W. B. Miller (V.), J. L. Gillespie (N.S.W.), H. J. Geddes (Tas.), P. S. Lang (Q.), the Hon. Treasurer, Mr. R. L. Twentyman, the Hon. Secretary, Mr. A. J. Vasey, and the Assistant Hon. Secretary, Mr. R. D. Croll. Mr. G. W. Leeper (proxy for A.C.T.) was present by invitation.

Professor Watt thanked the Council for the welcome and for arranging the date of the meeting to coincide with his visit to Melbourne.

The Hon. Secretary reported that a letter had been received from Mr. W. M. Scott accepting the office of Public Officer of the Institute for taxation matters.

A letter had been received from the Secretary, Department of Defence, recording the Minister's appreciation of the offer of the services of the Institute, and stating that, however, in the event of a national emergency, it would appear that the services of members would be absorbed by the several State governments in accordance with the plans which were being arranged. The letter was received, and it was decided that no further action should be taken.

On behalf of the N.S.W. Branch, Professor Watt raised again the question of the ultimate objects of the Institute in connection with the status and salaries survey. He informed the Council that the N.S.W. Branch found difficulty in appreciating what action was likely to be taken from the information supplied in the earlier circulars on this subject.

The matter was discussed at length by the Council, which saw no reason to elaborate the proposals made in the earlier circulars nor to commit itself in advance to any particular action until the survey was complete. Appropriate action would then be taken as a result of the findings of the survey.

In regard to the financial policy of the Council, the proxies indicated that their respective Branches were in favour of maintaining the present arrangements, but that any proposals for a worthwhile scheme of expansion of activities from any Branch should be given sympathetic consideration by the Council.

The following applicants were admitted to corporate membership: Crocker, R. L. (S.A.), Watson, R. H. (S.A.), Croll, R. D. (Vic.), Duncan, D. B. (N.S.W.), Bull, J. D. (N.S.W.). The following were elected student members: Milthorpe, F. L. (N.S.W.), Smith, J. D. (N.S.W.), Green, K. R. (N.S.W.).

The Hon. Secretary read a letter from Dr. A. J. Nicholson, notifying the Council of two decisions of the Central Plant Quarantine Committee, viz., that all correspondence and arrangements for the Committee should be handled by him, and that Dr. Dickson had been co-opted to the Committee.

The Hon. Secretary read a letter from Dr. A. E. V. Richardson, forwarding a circular letter from Professor Franco Angelini, Secretary-General of the International Federation of Technical Agriculturalists, regarding a conference of agronomical engineers to be held at Liège, Belgium, on 3rd September next.

The Hon. Secretary was directed to write to Mr. G. de V. Davis asking if he could attend this conference as delegate from the Institute. The Hon. Secretary was also to arrange with the Editor for a reference to be made to the conference in the next issue of the Journal.

The financial statement showed a balance at bank of £62 18s. 1d.

Professor Watt presented a motion from the N.S.W. Branch Committee to the effect that Branch delegates should receive an agenda paper at such time prior to each Council meeting that each delegate has an opportunity to assess Branch opinion and convey it to his proxy. The Hon. Secretary agreed that this would be a very desirable practice, but suggested that under present conditions it appeared to be impracticable. It would mean that no business for submission to a Council meeting could be accepted after the agenda had been prepared, and to reach all Branch secretaries this would be at least fourteen days before each Council meeting. With this point of view the Council agreed, and directed the Hon. Secretary to reply and assure the N.S.W. Branch that Branches would be given sufficient notice of any matters of policy to permit of their discussion and the notifying of proxies, but it felt that the present practice in regard to routine matters was working quite satisfactorily.

The meeting concluded at 10.55 p.m.

REPORTS OF EDITOR AND BUSINESS MANAGER.

The following are extracts from the reports presented by the Editor (Dr. H. J. Hynes) and the Business Manager (Dr. N. S. Noble) to the Council meeting at Canberra, January, 1939:

Editor's Biennial Report. In the two volumes (Nos. 3 and 4) published since the first general meeting of the Institute, there have been 60 pages of printed matter in each of the eight issues—representing an increase of 16 pages per issue over the number which appeared in Volumes 1 and 2. In Volumes 3 and 4 there have been published 10 editorials, 48 general articles, 29 technical notes and 27 book reviews—a total of 114 as against 93 in

Vols. 1 and 2. The position is interesting in respect of the numbers of general articles and technical notes submitted through the several branches of the Institute for publication in Volumes 3 and 4:

	General Articles.	*Technical Notes.*	*Totals.*
New South Wales ..	18	15	33
South Australia	13	5	18
Victoria	5	4	9
Canberra	5	0	5
Western Australia ..	3	2	5
Queensland	2	3	5
Tasmania	2	0	2

Grateful acknowledgment is made of the ready assistance and painstaking efforts of the Sub-Editors in the several Branches of the Institute.

Business Manager's Annual Report. During 1938, 600 copies of each of the four numbers of Volume 4 were printed. Of these, a total of 554 were distributed to members, subscribers and various institutions on the free or exchange list. There was an increase of 48 in the mailing list during the year, this increase comprising mainly new members. Two subscribers who paid for the Journal in 1937 ceased to subscribe in 1938, but there were four new subscribers, making the total 18 for 1938. Reprints of 30 articles from Volume 4—amounting to 5,500 copies—were issued to authors, this being almost twice the number printed in 1937. The great majority of these reprints were purchased by the various institutions by whom the authors are employed. During 1938 many more illustrations were submitted by authors, the total cost of reproducing these being £17 10s. 3d.—almost three times as much as the sum spent on blocks in any previous volume. The net cost of publication of Volume 4 was £146 18s. 8d. This includes only one item of £1 1s. for the repurchase of Journals—which is non-recurring expenditure. Receipts from subscribers and for the sale of back numbers amounted to £17 5s.

MEETINGS OF BRANCHES.

New South Wales Branch.

The fourth annual general meeting was held at Science House, Sydney, on 10th February. A new series of Branch By-laws conforming with the requirements of the Federal Constitution was adopted. Election of office-bearers for 1939 resulted as follows: President, Mr. E. Breakwell; Vice-President, Mr. E. A. Southee; Hon. Secretary, Mr. H. P. Brown; Hon. Treasurer, Mr. A. W. S. Moodie; Committee, Messrs. R. H. Anderson, C. J. Magee and D. O. Cross. Dr. R. J. Noble and Messrs. W. B. Gurney and J. N. Whittet were appointed as a sub-committee in connection with the Institute's project on plant quarantine. The Branch membership as at 31st December, 1938, was 98, showing an increase of 13 for the year. The balance at bank on 31st December, 1938, was £12 13s.

At the April meeting, 21 persons attended. The Secretary announced that Messrs. C. J. Magee and R. H. Anderson had been appointed Branch Delegate to the Federal Council and Convenor of Branch sub-committee for plant quarantine, respectively. The financial statement showed a credit balance of £36 10s. 4d. The main business of the evening was devoted to a discussion of the three Institute projects in which the Branch is participating: Agricultural Potentialities and Population Capacity of N.S.W. (Committee, Prof. Watt and Messrs. Reid, Holmes, Breakwell, Moodie, Savage and Davis), Plant

Quarantine, and Salaries and Status Survey (Committee, Hon. Secretary and Messrs. Wilson and Pont).

Victorian Branch.

The fourth annual meeting was held on March 31st, 45 members and visitors being present. Election of office-bearers for 1939-40 resulted as follows: President, Mr. W. B. Miller; Vice-President, Mr. F. M. Read; Hon. Treasurer, Mr. C. E. Cole; Hon. Secretary, Mr. A. B. Hackwell; Committee, Messrs. A. W. Jessep, H. J. Geddes, Professor S. M. Wadham (*ex officio*); Hon. Sub-Editor, Mr. F. S. Crawford; Hon. Auditor, Mr. O. H. Gepp.

The presidential address delivered by Mr. J. Brake, entitled "Men Wanted", appears elsewhere in this issue.

A presentation was made to the retiring Hon. Secretary, Mr. A. T. Pugsley, who has been appointed to a position at the Waite Institute, South Australia.

The steady growth of the Branch has been well maintained, there being, at the present time, 101 corporate members. Eleven meetings were held throughout the year (average attendance 66), seven of which were joint meetings with the Melbourne University Agricultural Society.

Sub-committees have been appointed to consider further (*a*) Agricultural Potentialities of Victoria, (*b*) Plant Quarantine, and (*c*) Status Salary and Survey.

Queensland Branch.

The annual meeting was held at the Department of Agriculture and Stock, Brisbane, on 31st March, 1939. The annual report of the Branch committee showed that corporate membership of the Branch had increased from 50 to 53 during the year, while student membership remained at a total of five. Eight meetings were held during the year, and at these meetings an innovation in the form of notes and exhibits was successfully introduced.

The Branch Constitution was revised, bringing it into line with the Federal Constitution. The credit balance of the Branch stood at £37 17s. 4d. on 31st December, 1938, and, in view of the sound financial position, the Branch committee lowered the Branch dues from five shillings per member to three shillings in the case of Brisbane corporate members, and to one shilling for country corporate members and student members.

Election of officers for the current year resulted as follows: President, Mr. A. F. Bell; Vice-President, Prof. E. J. Goddard; Vice-President and President-Elect, Mr. C. S. Christian; Secretary-Treasurer, Mr. C. W. Winders; Sub-Editor, Mr. J. A. Weddell: Committee, Messrs. L. F. Mandelson, P. J. Skerman and J. H. Smith.

The retiring President, Professor E. J. Goddard, delivered his presidential address, entitled "Man-power in the Service of Agricultural Science", published in this issue.

South Australian Branch.

The annual general meeting was held on March 23rd. The following office-bearers were elected for 1939: President, Mr. W. J. Spafford; Vice-President, Dr. A. R. Callaghan; Hon. Sub-Editor, Mr. D. B. Adam; Hon. Treasurer, Mr. C. S. Piper; Hon. Secretary, Mr. C. M. Donald; Committee, Professor J. A. Prescott, Drs. I. F. Phipps and A. Walkley. A local sub-committee was formed to cooperate with the central committee dealing with the subject of plant quarantine.

The meeting was addressed by Professor Ralph H. Carr, of Purdue University, Indiana, U.S.A., who described some of the effects of American New Deal legislation as it applied to agriculture. The speaker was sympathetic with much that had been achieved, though with such a body of novel legislation a degree of failure in some directions was unavoidable.

Professor Carr's own special interest, however, could not be denied. In the short time left to him he dealt most enthusiastically with soybeans, oats and other agricultural products as raw materials for chemurgists of today and the future.

Western Australian Branch.

The annual general meeting was held on 31st March, and the following office-bearers elected for the ensuing year: President, Dr. G. L. Sutton; Vice-President, Mr. A. M. Stewart; Secretary-Treasurer, Mr. R. P. Roberts; Sub-Editor, Mr. G. H. Burvill; Committee, Drs. L. J. H. Teakle and T. C. Dunne, and Messrs. G. K. Baron-Hay, W. P. Cass-Smith, I. Thomas and F. L. Shier; Student Representative, Mr. T. Robinson.

The retiring President, Dr. L. J. H. Teakle, delivered his presidential address, entitled "The Importance of 'Minor' Elements in Western Australian Agriculture", published in this issue.

On 21st April the Branch met at the Palace Hotel to tender a complimentary dinner to Professor J. E. Nichols prior to his departure to take up his new post of Deputy Director of the Imperial Bureau of Animal Breeding and Genetics in Edinburgh. Later in the evening Professor Nichols delivered an address on "Research in Animal Husbandry", in which he voiced some of the principles covered by his article published in this issue.

Current Notes and News

Doctorates Conferred.

The degree of D.Sc. of the University of Tasmania was conferred on Mr. J. W. Evans, Government Entomologist in the Tasmanian Department of Agriculture, at the Commemoration held last month.

Dr. Evans graduated at Cambridge in 1926 and arrived in Australia later in the same year. In 1927 he was granted a Commonwealth Science and Industry Endowment Studentship, and spent a year at the Cawthron Institute, New Zealand. After a short period in the United States he joined the staff of the Division of Entomology of the C.S.I.R. as one of its original members, and worked for a year at the parasite laboratory of the Imperial Institute of Entomology. Following his return to Australia in 1929, he was engaged on the apple thrips problem at Canberra, Melbourne and the Waite Institute. He was appointed to his present position in 1935.

Dr. Evans is president of the Tasmanian branch of the Institute, a member of the Council of the Royal Society of Tasmania, of the National Park Board and of the Board of Trustees of the Tasmanian Museum and Botanic Gardens. He is also the delegate of the Tasmanian Branch to the Federal Council of the Institute, and a member of the Central Committee of the Institute on Plant Quarantine.

A large number of published papers were submitted for the degree, the examiners being two leading English entomologists.

Mr. C. J. P. Magee, Plant Pathologist in the N.S.W. Department of Agriculture, was admitted to the D.Sc.Agr. degree, University of Sydney, last month. The title of the thesis was "Studies on the Bunchy Top Disease of Bananas and other *Musa* spp.".

Dr. Magee matriculated from Sydney High School in 1920 and secured the B.Sc.Agr. degree (honours) at Sydney University in 1924. He then joined the N.S.W. Department of Agriculture as Assistant Biologist, and was seconded to the Banana Bunchy Top Investigation Committee (Professors Watt, Goddard and Osborne) in May, 1924, spending

two years at Tweed Heads investigating the nature and control of the bunchy top disease. The banana industry had been practically annihilated as the result of bunchy top, and Dr. Magee's investigations laid the foundation for the rebuilding of the industry.

In 1926 he proceeded to the University of Wisconsin as Ben Fuller Travelling Scholar to continue his studies on virus diseases. Whilst at Wisconsin he secured his M.Sc., and passed the preliminary examination for the Ph.D. degree. He rejoined the State department in 1928, and was appointed Plant Pathologist in 1932. Since 1936 special attention has again been given to problems in the banana industry—mainly in connection with testing of varieties for resistance to bunchy top.

Dr. Magee is the author of several papers on plant pathological subjects. He is the delegate of the N.S.W. Branch to the Federal Council of the Institute, and was president of the S.U. Agricultural Graduates' Association in 1930.

Agricultural Sciences Club.

The eleventh annual general meeting was held at the Waite Institute on April 27th. Mr. R. J. Best was elected President of the Club for the current year. The other offices filled were: Vice-President, Dr. A. H. K. Petrie; Hon. Secretary, Mr. T. T. Colquhoun; Committee, Dr. I. F. Phipps, Professor J. A. Prescott, Mr. D. C. Swan.

Dr. Walkley read a paper on "Trace Elements in Commercial Fertilisers", and discussed the procedure for determining some of the heavy metals in fertilisers, the method consisting of extraction by the organic reagent dithizone and subsequent determination by means of a self-recording polarograph. Analyses of a group of fertilisers, which included all the important types used in Australia, revealed that the potassic and nitrogenous fertilisers, for the most part, had a very low content of heavy metals. Superphosphate samples, on the other hand, contained appreciable amounts of zinc.

Mr. Oertel read a paper on "Spectrographic Analyses of Soils and Plant Ashes—Some Difficulties". After outlining the bases of qualitative and quantitative analyses by means of the spectrograph, he went on to describe the limitations of the method. In the first place, not all the elements in a sample are excited by any one source of energy, so that analyses can only refer to those elements excited by the source employed. The sampling of materials also presents difficulties. In practice it is impossible to obtain a soil sample small enough for complete analysis and yet large enough to be truly representative of the bulk from which it is drawn. These limitations, however, do not apply to soil extracts, of whose composition a more accurate picture can be obtained. Plant ash materials present the same sort of difficulties as soils, but careful grinding and mixing both before and after ashing is very helpful.

Melbourne University Agricultural Society.

The seventeenth annual meeting of the M.U.A.S. was held on April 21st. The membership in 1938 reached a total of 147, including 16 life members. During the year eight meetings were held, and the average attendance was 57. The following office-bearers were elected for 1939: President, Mr. L. C. Bartels; Vice-Presidents, Messrs. O. H. Gepp, and R. L. Twentyman; Hon. Treasurer, Mr. A. O'Brien; Hon. Secretaries, Messrs. A. A. Lee and T. C. Bell; Graduate Representative, Mr. J. L. Provan; Undergraduate Representative, Mr. R. W. Spicer; *ex officio* Mr. J. A. Aird, and the Professor of Agriculture (Mr. G. W. Leeper—acting).

The address for the evening was given by the retiring president, Mr. J. A. Aird, the title being "Rainfall, Production and Population". Mr. Aird showed some of the relationships existing between the average rainfall, rainfall in a drought year, and the amount of water necessary to maintain and increase present production and population. This

paper represented a new angle on the population problem of which the Institute is making a special study, and gave rise to considerable discussion. The address will be published in the September issue of this Journal.

Nature and Measurement of Soil Structure.

A paper on this subject was presented by Messrs. R. G. Downes and G. W. Leeper at the Canberra Meeting of the A.N.Z.A.A.S. in January last. The following is a brief summary:

It has been recognized for a long time that the properties of soil in the field are very different from those of the ground-up material which is analysed in the laboratory. The individual particles which are measured in mechanical analysis exist in the field partly or wholly as composite units or aggregates, and the degree and permanence of such aggregation, or structure, is a most important practical property determining aeration, drainage, and ease of working, and is often connected with liability to erosion. Various methods have been suggested for measuring structure in the laboratory, and we have attempted to standardize the most promising of these, and to see how far a known difference between two soil types or between two differently treated plots of the same soil type is reflected quantitatively in laboratory measurements. The most promising method, suggested by Meyer and Rennenkampff, measures the percentage of the soil retained by a ¼ mm. sieve under constant washing with water. The amount of soil other than coarse sand so retained varies from about 90 per cent. for a granular ferruginous clay from Kerikeri, N.Z., to as little as 5 per cent. for the hard-packing sandy loam of the State Experimental Farm at Rutherglen, Victoria. This method also gives satisfactory correlations with differences in treatment within one type, and appears to measure the degree of deterioration which is brought about by a sequence of crop and fallow.

Rice Culture in Australia.

At the Canberra Meeting of the A.N.Z.A.A.S. in January last, Mr. W. H. Poggendorff, Assistant Plant Breeder in the N.S.W. Dept. of Agriculture, presented a paper on "Rice Culture in Australia", of which the following is a brief summary:

According to published statistics, rice (*Oryza sativa* L.) ranks next to wheat as the greatest of the world's crops. Its culture in Australia is limited by demand and water supply. Rice has been grown on a small scale in Queensland, the Northern Territory, Western Australia, and Victoria, but by agreement between the States, commercial culture on a large scale is confined to New South Wales, where it became established on the Murrumbidgee Irrigation Area in 1924, following the introduction of Californian short-grain varieties which proved very suitable. The Rice Research Station was established by the N.S.W. Department of Agriculture in 1929 to conduct breeding and experimental work.

The "flooded" method of culture is used, after dry sowing about October; harvesting takes place about April. Wheat machinery has been adapted to handle the crop. From 6 to 8 acre-feet of water are necessary to grow a crop to maturity. Some 24,000 acres were grown last season, yielding 42,000 tons of paddy, of which about half supplies Australian requirements and the remainder is exported, chiefly to England, where it enjoys a preferential tariff of 1d. per pound. Australia is the only part of the British Empire producing short-grain rice, which is popular on the London market. Any further extension of rice culture in Australia must be dependent upon demand and the development of further water supplies.

Imperial Bureau of Dairy Science.

In 1936, the British Commonwealth Scientific Conference which met in London recommended that a new Imperial Bureau of Dairy Science be established. The conference also suggested the National Institute for Research in Dairying as the most suitable location for the bureau. Following agreement by all the authorities concerned, the new Imperial Bureau of Dairy Science was established late last year at Shinfield, near Reading. Prof. H. D. Kay, O.B.E., Ph.D., D.Sc., Director of the National Institute for Research in Dairying, has been appointed Director of the Bureau. The Bureau is financed cooperatively by the governments of the British Empire in the same way as the other Imperial agricultural bureaux.

The functions of the Bureau are to index research work in dairy science, whether carried out in the Empire or elsewhere ; to collect, abstract and collate information bearing on dairy science and to distribute such information both by publication and by private communication to research workers, officials, and advisory officers throughout the Empire. In addition, the Bureau is charged with the duty of establishing and maintaining contact between research workers with common interests, promoting conferences of workers and visits to research centres, and in general encouraging the circulation of information ideas, material and personnel. The field of dairy science to be covered by the Bureau includes the microbiology, chemistry, and physics of milk and its products ; animal diseases in so far as they affect milk and its products ; the technology of processing milk and manufacturing dairy products ; the physiology of milk secretion as affecting quality and quantity of milk and dairy products ; standards for the composition and quality of milk and its products.

Bibliography of Agricultural Economics.

The International Institute of Agriculture in Rome commenced last year to publish a current bibliography, at quarterly intervals, which will deal with agricultural economics in all its various phases. This bibliography will be based on the material received by the library of the Institute.

The scope of the bibliography covers the economic and social aspects of agriculture, such as agricultural economics, agricultural policy, settlement, credit, cooperation, insurance, marketing, prices, statistics, farm organisation and management, valuation, labour, accounting, and closely allied subjects such as rural sociology, agricultural history and geography, legislation and education. Titles of all publications, whether books and pamphlets or articles in periodicals, are given and all bibliographical details required for proper identification. All languages receive equal treatment and titles in the less known languages are provided with a translation.

The bibliography is carefully classified by subjects. An author-index will be supplied at the end of each volume. The annual subscription, postage included, is seven shillings.

" Agricultural Engineers' Day."

Advice has been received that the Co-ordinating Committee of Belgian Associations of Agricultural Engineers is organising an " Agricultural Engineers' Day " at Liège, Belgium, on September 3rd, 1939, under the auspices of the International Federation of Technical Agriculturists. The function is part of the " 15th International Agricultural Exposition " (August 27th to September 10th). Addresses on " Water in Agriculture and in Agricultural Industries " will be read and discussed during the " Engineers' Day ". Further particulars are available on application to the Editor of this Journal.

Book Reviews

"HUMUS", by S. A. Waksman.

(*Second Edition. Pp. xiv+526, with 44 figures. London : Baillière, Tindall & Cox*, 1938.)

As the author remarks in the preface, "No other phase of chemistry has been so much confused as that of humus". The greatest credit in dispelling the obscurity which shrouded the subject is due to Waksman and his twenty-five research workers, who tackled the problem as microbiologists and adopted a point of view which now seems obvious. Waksman's argument was simple: we know that plants contain so much cellulose, protein, lignin and other materials; then why not follow up each of these in the soil and find how much of it remains after a week, a month, or a year? The "proximate" methods used for analysing plants were thus applied to humus, and the problem came close to a solution. Waksman showed that cellulose is rapidly used by bacteria, and lignin is resistant and therefore makes up an increasing proportion of the total humus as time goes on. But both the protein and the lignin are more stable in humus than in the free state. It was suggested, therefore, that the two are combined to form a resistant "lignoprotein", constituting most of the humus. This is a colloidal complex which retains the acid properties of lignin, and is responsible for the high capacity of the organic matter of the soil to react with bases.

The whole of this argument is present in Waksman's treatise. It is not, however, in an easily absorbed form, and one's regretful conclusion after reading the book is that it will not play a great part in bringing the valuable ideas of Waksman's school before the general agricultural reader. The book is a huge collection of material in which the reader is often at a loss for guidance. Incompatible opinions are quoted with the same detailed scrupulousness as is shown in the numerous tables in which the results of proximate analyses are quoted to the nearest part in 10,000. In spite of this, the book will yield a great deal of most valuable information to the diligent searcher. For the information of the busy reader, the best parts of the book, in which the author sets out his own ideas, are in Chapters I, VII, X and XIV, and pages 120 to 129.

This is the second edition, in which a few slight corrections and additions have been made to the letterpress and figures of the first edition, the number of articles quoted in the bibliography has risen from 1,311 to 1,608, and a short and interesting chapter has been added on "Humus and Soil Conservation".

There is an urgent need for a small, cheap book which shall embody the modern conceptions of humus in a straightforward way. May one hope that the distinguished author of the volume under review will undertake this task himself?

G. W. Leeper.

SOILLESS GROWTH OF PLANTS, by Carleton Ellis and Miller W. Swaney.

(*Pp. 155, with 59 illustrations (3 in colour). New York : Reinhold Publishing Corporation*, 1938. *Price (London)*, 13/6.)

The public demand lately evinced for information relating to the cultivation of plants in nutrient solutions makes this little book particularly welcome at the present time. The authors have contrived, in exceedingly clear and non-technical language, to explain the principles of "soilless" growth or the cultivation of plants by the aid of chemical solutions. The useful, introductory chapter deals with "the Chemistry of Plant Life". The succeeding chapters are full of interest and contain much detailed information regarding the preparation of nutrient solutions, the most suitable containers to use, and the general technique which should be employed in sand culture, sub-irrigation and water cultures, in order to secure the best results.

The commercial aspects of " soilless " growth are also discussed and accounts given of several large-scale projects in which the cultivation of tomatoes, melons, sweet peas, carnations and other vegetable and flower crops have been attempted. While expressing their belief in the future possibilities of " hydroponics ", water culture, or tank farming, the authors have wisely attempted to repudiate some of the more exaggerated claims that are from time to time made for this method of plant production. The technical difficulties likely to be encountered by the amateur are mentioned, and the importance of maintaining an optimum reaction in the nutrient solution and adequate aeration of the latter is emphasised.

Finally, the effects on plants of some special chemical agents, such as the plant hormones, are dealt with in a simple way. Reference is also made to the recently discovered effect of the alkaloid colchicine in inducing chromosome doubling ; of ethylene chlorohydrin on dormant tubers and of thiourea on lettuce seed germination. The possible application of this new knowledge to horticultural practice is indicated. The book is profusely illustrated and should serve as a useful guide to anyone who proposes, either for pleasure or profit, to engage in this newer method of plant production.

E. Griffiths.

SILAGE AND CROP PRESERVATION, by S. J. Watson, D.Sc., F.I.C.

(*Pp.* 166 *with* 10 *plates, tables and plans. London : Messrs. Macmillan & Co., Ltd.,* 1938. *Price,* 7/6 *net.*)

This most readable book discusses the respective merits and difficulties of the present methods of fodder conservation as practised in Great Britain, particularly in relation to modern grassland management. The main purpose of crop conservation should be to make, not as is so frequently done, a roughage of low digestibility and feeding value, but a foodstuff of good protein value which will provide a more suitable ration for high-producing animals. Dr. Watson explains the difficulty of achieving this by means of hay making, even when assisted by racks, tripods or " pick-up " balers. He explains that artificial grass drying is the natural outcome of this desire to improve the quality of the conserved fodder, and where properly conducted this process leaves little room for further improvement in the quality of the finished product. The process, however, involves an expensive drying apparatus, heavy haulage of green material, high operating charges, baling and good storage facilities, and a degree of skill and attention which, if applied to silage making, would result in a product having in its dry material a feeding value almost as high as artificially dried grass hay. Bad planning, careless storage and inattention to detail have in the past resulted in silage making having achieved a reputation for heavy work and excessive wastage.

The author explains very clearly what happens to the green crop when it is ensiled under different conditions in the earth-pit, stack, or solid container, and how rapid advances in the knowledge of the processes at work have made it easy to prepare a fodder with a very much higher feeding value than grass hay. He shows how most of the difficulties may be readily overcome by the use of the portable silo and the storage of more leafy nutritious fodder. Complete instructions for the building and filling of the silos are given, and excellent photographs throughout the book show how simple is the actual process.

R. L. Twentyman.

Obituary

A. C. DREVERMANN

It is with regret that we have to record the death, on 30th May, 1939, of Mr. Albert Cameron Drevermann, former Principal of Longerenong and Dookie Agricultural Colleges, Victoria, and a member of the Victorian Branch of the A.I.A.S.

Born at Bairnsdale (Vic.) sixty-one years ago, Mr. Drevermann had a lifelong association with agricultural education in Victoria. He was one of the earliest students of Dookie College, being dux in 1895. He continued his studies at the Bairnsdale School of Mines, then for three years was engaged as a chemist on the staff of the Victorian Department of Agriculture.

In 1900 Mr. Drevermann returned to Dookie College as Science Master, which position he held until 1912. He was then appointed Principal of Longerenong College (1912–27) and subsequently Principal of Dookie College (1927–38), from which post he retired only in September last.

For many years Mr. Drevermann was a conspicuous and forceful figure in the sphere of agricultural education. In his capacity of teacher and principal, he won the respect and affection of his many students, all of whom must be grateful for his kindly and tactful guidance. He had a profound love for and knowledge of youth and the land, and was highly successful in fitting the one for the other. In his many years of close association with agricultural interests, he became personally acquainted with a large proportion of the farming community and acquired an intimate knowledge of Australian agriculture.

Mr. Drevermann was a man of great personality, with a keen public spirit, and a staunch advocate of scientific research. His influence in the agricultural educational life of Victoria will long be remembered.

Personal Notes

Mr. S. L. Macindoe, Plant Breeder in the N.S.W. Department of Agriculture, has been awarded a Commonwealth Fund Service Fellowship, and is proceeding to the U.S.A. in August.

Mr. T. McCarthy, Senior Assistant Entomologist in the N.S.W. Department of Agriculture, left Sydney for the United States on April 28th. Mr. McCarthy intends to visit the United States, Canada, England, and possibly Algeria and South Africa for the purpose of studying the organisation of grasshopper control work.

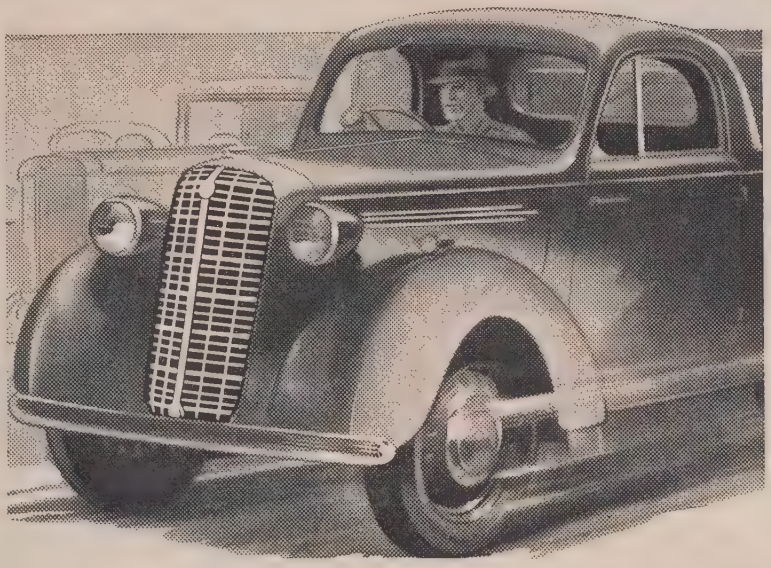
Mr. R. D. Croll has been appointed Science Field Officer in the Victorian Department of Agriculture.

Mr. A. B. Cashmore has been transferred from the Weeds Section of the Division of Plant Industry, C.S.I.R., to the Agrostological Section. He is now stationed in Perth to work on agrostological problems in Western Australia.

Mr. R. V. Fyfe, of the Division of Economic Entomology, C.S.I.R., has been awarded a Walter and Eliza Hall Fellowship of Sydney University. Mr. Fyfe intends to study insect physiology and allied subjects at the Zoology School, Cambridge.

Mr. A. T. Pugsley, formerly of the Department of Agriculture, Victoria, commenced duties as Assistant Plant Geneticist at the Waite Institute in May.

At the recent Degree Day ceremony of the University of Queensland, Mr. N. E. H. Caldwell was admitted to the M.Sc.Agr. degree, and Mr. L. G. Vallance to the M.Sc. degree.



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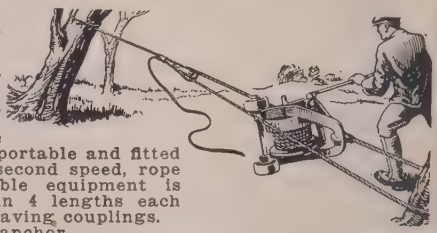

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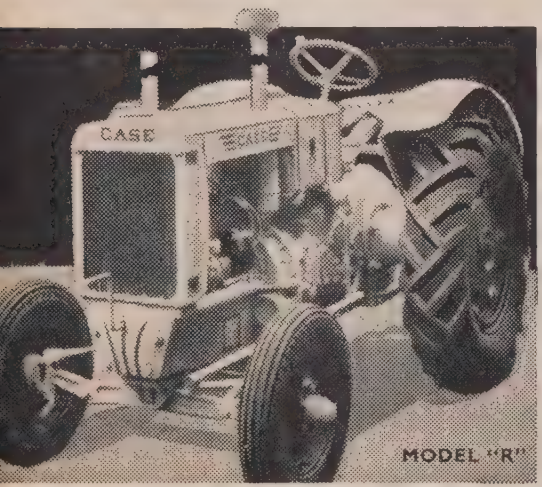

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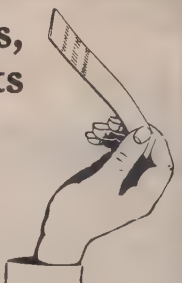

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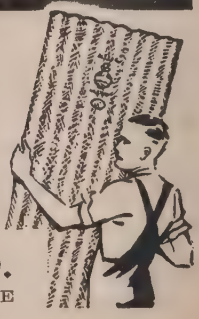

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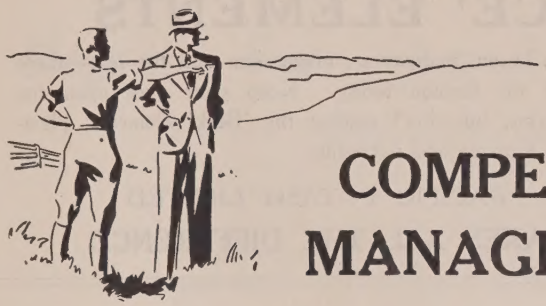

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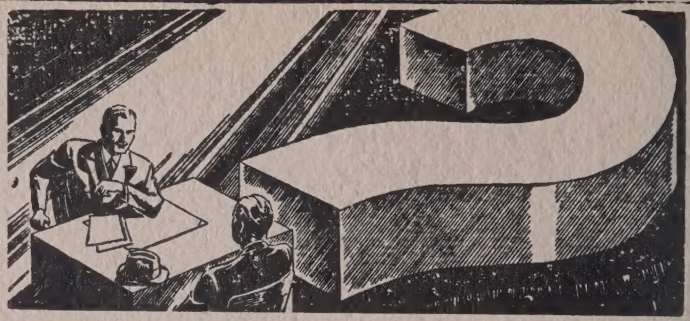

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